EXCION

SERVICE MANUAL

Index

GENERAL INFORMATION

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings are used in this manual to emphasize important and critical instructions.
They are used for the following conditions:

NOTE

Denotes situations which could influence safety or proper performance of the vehicle or component and to highlight an essential operating procedure or condition.

⚠ CAUTION

Operating procedures or practices that will result in damage to or destruction of the engine if not strictly observed.

⚠ WARNING

Operating procedures or practices that will result in serious injury or loss of life if not correctly followed.

Fuel Systems Cautions

⚠ WARNING

Do not smoke, carry lighted tobacco, or use a lighted flame of any type when working on or near any fuel related component.
Highly flammable air-fuel mixtures may be present and can be ignited causing personal injury.

⚠ WARNING

Do not allow propane to contact the skin.
Propane is stored in the fuel tank as a liquid.
When propane contacts the atmosphere, it immediately expands into a gas, resulting in refrigeration that can cause severe burns.

⚠ WARNING

Do not allow propane to accumulate in areas below ground level such as in a service pit or underground ventilation systems. Propane is heavier than air and can displace oxygen, creating a dangerous condition.

It is important to note that this manual contains various Warnings, Cautions and Notes that must be carefully observed in order to reduce the risk of personal injury during service or repair.
Improper service or repair may damage the engine or render it unsafe or fail to make the engine emissions compliant.
It is also important to warn of all hazardous consequences that might result from careless treatment of the engine. Failure to observe these items could influence terms of the warranty.
To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed.

Proper service and repair are important to the safety of the service technician and the safe reliable operation of all engines. The service procedures recommended and described in this service manual are effective methods of performing service and repair.
Some of these procedures require the use of tools specially designed for the purpose.

If part replacement is necessary, the replacement part must be of the same part number or equivalent part. Do not use a replacement part of lesser quality. In the case of replacement parts for the emission control system use only genuine OEM replacement parts.

Before using a replacement part, service procedure, or a tool which is not recommended by the engine manufacturer, it must first be determined that neither personal safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or the tool selected.

English and Metric Fasteners

⚠ CAUTION

Late model engines use a combination of English and Metric fasteners. The components affected are the starter motor, engine mounts,

and flywheel housing mounting.
Other components may also have a combination of fasteners, always verify that the proper fasteners are used whenever removing or replacing any components.

Handling Electrostatic Discharge (ESD) Sensitive Parts

Many solid state electrical components can be damaged by electrostatic discharge (ESD). Some will display a label, but many will not. In order to avoid possibly damaging any components, observe the following:

1. Body movement produces an electrostatic charge. To discharge personal static electricity, touch a ground point (metal) on the vehicle.
This should be done any time you:

- Slide across the vehicle seat.
- Sit down or get up.
- Do any walking.

2. Do not touch exposed electric terminals on components with your finger or any tools. Remember, the connector that you are checking might be tied into .a circuit that could be damaged ‘by electrostatic discharge.

3. When using a screwdriver or similar tool to disconnect a connector, never let the tool come in contact with or come between the

exposed terminals.

4. Never jumper, ground, or use test equipment probes on any components or connectors unless specified in diagnosis. When using test equipment, always connect the ground lead first.

5. Do not remove the solid state component from its protective packaging until you are ready to install the part.

6. Always touch the solid state components package to a ground before opening. Solid state components can also be damaged if:

- They are bumped or dropped.

- They are laid on any metal work benches or components that operate electrically, such as a TV, radio, or oscilloscope.

GLOSSARY OF TERMS

Air/Fuel Ratio: The amount of air and fuel in the air fuel mixture, which enters the engine, shown in a ratio.
Analog Voltmeter: A meter that uses a needle to point to a value on a scale of numbers usually of the low impedance type; used to measure voltage and resistance.
Aromatics: Pertaining to or containing the six-carbon ring characteristic of the benzene series. Found in many crude oils.
Backfire: Combustion of the air/fuel mixture in the intake or exhaust manifolds. A backfire can occur if the intake or exhaust valves are open when there is a mis-timed ignition spark.
Benzene: An aromatic (C6H6). Sometimes blended with gasoline to improve antiknock value. Benzene is toxic and suspected of causing cancer.
Bi-Fueled: A vehicle equipped to run on two fuels at the same time such as a fumigated diesel.
Blow-By: Gases formed by the combustion of fuel and air, which ordinarily should exert pressure only against the piston crown and first compression ring. When rings do not seal, these gases (blowby) escape down the side of the piston into the crankcase.
BTU: British Thermal Unit. A measurement of the amount of heat required to raise the temperature of 1lb. of water 1 degree F.
Butane: An odorless, colorless gas, C4H10 found in natural gas and petroleum. One of the five LP gases.
CAFE: Corporate Average Fuel Economy.
CARB: California Air Resources Board.
Carbon Monoxide (CO): A chemical compound of a highly toxic gas that is both odorless and colorless.
Carburetor: An apparatus for supplying an internal-combustion engine a mixture of vaporized fuel and air.
Cathode Ray Tube: A vacuum tube in which cathode rays usually in the form of a slender beam are projected on a fluorescent screen and produce a luminous spot.
Circuit: A path of conductors through which electricity flows before it returns to its source.
Closed Loop Operation: Applies to systems utilizing an oxygen sensor. In this mode of operation, the system uses oxygen sensor information to determine air/fuel ratio. Adjustments are made accordingly and checked by comparing the new oxygen sensor to previous signals. No stored information is used.
CNG: Compressed Natural Gas.
CKP: Crankshaft Position Sensor
CMP: Camshaft Position Sensor
Conductor: A material, normally metallic, that permits easy passage of electricity.
Contaminants: Impurities or foreign material present in fuel.
Control Module: One of several names for a solid state microcomputer which monitors engine conditions and controls certain engine functions; i.e. air/fuel ratio, injection and ignition time, etc.
Converter: A LPG fuel system component containing varying stages of fuel pressure regulation combined with a vaporizer.
Cryogen: A refrigerant used to obtain very low temperatures.
Current: The directed flow of electrons through a conductor. Measured in amps.
Dedicated Fuel System: A motor fuel system designed to operate on only one fuel type.
Diaphragm: A thin, flexible membrane that separates two chambers. When the pressure in one chamber is lower than in the other chamber, the diaphragm will move toward the side with the low pressure.
Diaphragm Port: The external port located at the fuel inlet assembly and connected to the vacuum chamber above the air valve diaphragm.
Digital Volt/Ohm Meter (DVOM): A meter that uses a numerical display in place of a gauge and is usually of the high impedance type.
DTC: Diagnostic Trouble Code
DST: Diagnostic Scan Tool.
DVOM: Digital volt/ohmmeter.
ECM : Electronic Control module
EFI: Electronic Fuel Injection. A fuel injection system, which uses a microcomputer to determine and control the amount of fuel, required by, and injected into, a particular engine.
EGR: Exhaust gas recirculation.
EPA: Environmental Protection Agency: A regulating agency of the Federal government which,

among other duties, establishes and enforces automotive emissions standards.
Ethanol: Grain alcohol (C2H5OH), generally produced by fermenting starch or sugar crops.
Evaporative Emissions Controls: An automotive emission control system designed to reduce hydrocarbon emissions by trapping evaporated fuel vapors from the fuel system.
Excess Flow Valve: A check valve that is caused to close by the fuel when the flow exceeds a predetermined rate.
EXCION: Products Company. EXCION Co., Ltd.. A manufacturer of both LPG and Gasoline fuel systems.
Forced Idle: ECM commands electronic throttle controller to an idle position.
FFV: Flexible Fuel Vehicle.
Firing Line: The portion of an oscilloscope pattern that represents the total amount of voltage being expended through the secondary circuit.
FMVSS: Federal Motor Vehicle Safety Standards.
FPP: Foot Pedal Position Sensor
Fuel Injector:, a spring loaded, electromagnetic valve which delivers fuel into the intake manifold, in response to electrical from the control module.
Fuel Lock: A solenoid-controlled valve located in the fuel line to stop the flow when the engine stops or the ignition switch is off.
Gasohol: 10 percent ethanol, 90 percent gasoline. Often referred to as E-10.
Gasoline: A motor vehicle fuel that is a complex blend of hydrocarbons and additives. Typical octane level is 89.
Greenhouse Effect: A scientific theory that suggests that excessive levels of carbon dioxide from the burning of fossil fuels is causing the atmosphere to trap heat and cause global warming.
HD 10: A fuel of not less than 80% liquid volume propane and not more than 10% liquid volume propylene.
HD 5: A fuel of not less than 90% liquid volume propane and not more than 5% liquid volume propylene.
HDV: Heavy Duty Vehicle.
Hg: Chemical symbol for mercury. Used in reference to vacuum (in. of Hg).
Hydrocarbon: A chemical compound made up of hydrogen and carbon (HC). A major pollution emission of the internal combustion engine. Gasoline and almost all other fuels are hydrocarbons.
Hydrostatic Relief Valve: A pressure relief device installed in the liquid propane hose on a propane fuel system.
IAT: Intake Air Temperature
Ideal Mixture: The air/fuel ratio at which the best compromise of engine performance to exhaust emissions is obtained.
Typically 14.7:1.
Ignition Reserve: The difference between available voltage and the required voltage.
ILEV: Inherently Low Emission Vehicle.
Impedance: A form of opposition of AC current flow (resistance) measured in ohms.
Insulation: A nonconductive material used to cover wires in electrical circuits to prevent the leakage of electricity and to protect the wire from corrosion.
Intercept: An electrical term for a type of splice where the original circuit is interrupted and redirected through another circuit.
Knock: Sound produced when an engine’s air/fuel mixture is ignited by something other than the spark plug, such as a hot spot in the combustion chamber. Can be caused by a fuel with an octane rating that is too low or maladjusted ignition timing. Also called detonation or ping.
Lambda Sensor: A feedback device, usually located in the exhaust manifold, which detects the amount of oxygen present in exhaust gases in relation to the surrounding atmosphere.
LDV: Light Duty Vehicle.
Lean Mixture: An air to fuel ratio above the stoichiometric ratio; too much air.
LEV: Low Emission Vehicle.
Limp-in or Limp-home: This term is used to describe the drivability characteristics of a failed computer system.
Liquified Petroleum Gas (LPG): A fuel commonly known as propane consisting mostly of propane (C3H8), derived from the liquid components of natural gas stripped out before the gas enters the pipeline, and the lightest hydrocarbons produced during petroleum refining. Octane level is 107.
Low Rev Limit Secondary engine speed control, only used to limit speed when throttle positioning is

not maintaining desired speed.
LPG: Liquified Petroleum Gas.
LSV: LPG Solenoid Valve
LV: LPG Vaporizer
M85: A blend of gasoline and methanol consisting of 85% methanol and 15% gasoline.
Measurements of Pressure: 1 PSI=2.06 Hg (mercury) = 27.72” H2O (water column). At sea level atmospheric pressure is 29.92” Hg.
Methanol: Known as wood alcohol (CH3OH), a light, volatile, flammable alcohol commonly made from natural gas.
Misfire: Failure of the air/fuel mixture to ignite during the power stroke.
Mixer: Fuel introduction device that does not include a throttle plate.
MPFI: Multi-Point Fuel injection. A fuel injection system that uses one injector per cylinder mounted on the engine to spray fuel near the intake valve area of combustion chamber.
MTBE: Methyl Tertiary Butyl Ether. Oxygenate add to gasoline to reduce harmful emissions and to improve the octane rating.
Multi-fuel System: A motor fuel system designed to operate on two different fuels, such as LPG and gasoline.
Natural Gas: A gas formed naturally from buried organic material, composed of a mixture of hydrocarbons, with methane(CH4) being the dominant component.
NGV: Natural Gas Vehicle.
Nox: See Oxides of Nitrogen.
Octane Rating: The measurement of the antiknock value of a motor fuel.
OEM: Original Equipment Manufacturer, the vehicle manufacturer.
Open-Loop: An operational mode during which control module memory information is used to determine air/fuel ratio, injection timing, etc., as opposed to actual oxygen sensor input.
Orifice: A port or passage with a calibrated opening designed to control or limit the amount of flow through it.
Oscilloscope: An instrument that converts voltage and frequency readings into traces on a-cathode ray tube (also see Cathode Ray Tube).
Oxides of Nitrogen: Chemical compounds of nitrogen bonded to various amounts of oxygen (Nox). A chief smog forming - agent.
Oxygen Sensor: An automotive fuel system that produces a signal in accordance with the oxygen content of the exhaust gas. (See Lambda Sensor).
Oxygenate: MTBE, ethanol and methanol. Oxygenates are added to gasoline to increase the oxygen content and therefore reduce exhaust emissions.
Ozone: A radical oxygen module (O3) that is found in the upper atmosphere and filters out ultraviolet radiation from the sun. Ground level ozone is formed by Nox, during the formation of photochemical smog.
Particulates: Microscopic pieces of solid or liquid substances such as lead and carbon that are discharged into the atmosphere by internal combustion engines.
Positive Crankcase Ventilation (PCV): An automotive emission control system designed to reduce hydrocarbon emissions by routing crankcase fumes into the intake manifold rather than to the atmosphere.
Power Derate Level 1 ECM has detected condition in throttle control and limits throttle blade opening to 50%
Power Derate Level 2 ECM has detected condition in throttle control and limits throttle blade opening to 20%
Pressure Differential: The differential between atmospheric pressure and intake manifold (referred to as vacuum) pressure.
Pressure Regulator: A device to control the pressure of fuel delivered to the fuel injector(s).
Primary Circuit: The low-voltage or input side of the ignition coil.
Propane: An odorless, colorless gas, C3H8, found in natural gas and petroleum.
Reactivity: Refers to the tendency of an HC in the presence of Nox and sunlight to cause a smog - forming reaction.The lighter the HC, the lower reactivity tends to be.
Resistance: The opposition to the flow of current in an electrical circuit. Measured in ohms.
Vaporizer: An assembly used to reduce and control the pressure of a liquid or vapor.
WTS: Engine Water Temperature Sensor.

MAINTAINENCE

Maintenance

The maintenance of the engine and its related components is critical to the life of the engine and optimum performance during its useful life. All engines require a certain amount of maintenance. The suggested maintenance requirements are contained in this section. Industrial engines operate in various environments from extremely dusty environments, to hot and cold temperature environments and clean environments.
The recommended schedule is a recommended guide line for the owner and servicing agency to follow, however certain environmental operating conditions may require more frequent inspection and maintenance. In addition the owner may have installed additional equipment to the equipment which may also increase the requirements for service on certain components. Therefore the owner and servicing agent should review the operating condition of the equipment and determine if more frequent inspections and maintenance cycles maybe required.

⚠ WARNING

The engine installed in this equipment may use one or both accessory drive belt configurations. The drive belt may be incorporated to drive the water pump, alternator and addition pumps or devices. It is important to note, the drive belt is an integral part of the cooling and charging system and should be inspected at a minimum according to the maintenance schedule in this section and in extremely hot and dirty environments more often.

When inspecting the belts check for:

• Cracks,
• Chunking of the belt,
• Splits
• Material hanging loose from the belt
• Glazing, hardening

If any of these conditions exist the belt should be replaced with an OEM replacement belt.

V-Belt Systems

Check the belt tension by pressing down on the midway point of the longest stretch between two

pulleys. The belt should not depress beyond 13mm(1/2 inch). If the depression is more than allowable adjust the tension. Do not over tighten the tension of the belt. Over tightening may cause overload on the bearings and pulleys of the drive belt components.

Serpentine Belt System

Serpentine belts utilize a spring-loaded tensioner which keeps the belt properly adjusted. Serpentine belts should be checked according to the maintenance schedule in this section.

NOTE

The engine manufacturer does not recommend the use of “belt dressing” or “anti slipping agents” on either belt configuration.

Cooling System

⚠ WARNING

It is important to remember that the cooling system of this engine be maintained properly to insure the longevity of the engine. Maintenance of the cooling system is critical to not only the engine but the fuel system as well. Because the LPG vaporizer is connected into the cooling system low coolant levels and restricted or plugged radiator cores can impact the performance of the fuel system.
Therefore proper maintenance of the cooling system should include removing dust, dirt and debris from the radiator core on regular intervals. To properly maintain the cooling system follow the recommend maintenance schedule in this section.

Cooling system inspections should be performed as prescribed when inspecting the cooling system check for the following:

• Plugged or restricted radiator core clean with compressed air, blow dust and debris from the

core and the fan shroud

• Check the radiator cap to insure proper sealing if damage replace

• Check for coolant leaks at the radiator tank

seams and inlet joints repair or replace as necessary

• Check for leaks at the radiator hose connections, tighten hose clamps if necessary

• Check Radiator hoses for swelling, separation, cracks deterioration in the hoses, or hardening, if any of these conditions exist the hose should be replaced with the OEM replacement parts

• Check coolant level if low add with 50/50 mixture, Do not add plain water

• Replace coolant per the recommended schedule at the end of this section

CHECKING THE COOLANT LEVEL

⚠ WARNING

Do not remove the cooling system pressure cap when the engine is hot. Allow the engine to cool and then remove the cap slowly allowing pressure to vent. Hot coolant under pressure may discharge violently.

1. Check coolant level in coolant recovery tank. Add specified coolant as required.

NOTE

The engine manufacturer and the fuel system supplier do not recommend the use of “stop leak” additives to repair leaks in the cooling system. If leaks are present the radiator should be removed and repaired.

If the radiator requires repair insure that the radiator core repairs did not result in a significant reduction in the cooling capacity of the radiator.

The engine manufacturer recommends the cooling system be filled with a 50/50 mixture of ethelyeneglychol anti-freeze and water.

This HMC engine can utilize any type of permanent antifreeze or any brand antifreeze solution that meets HMC Specification which will not damage aluminum parts.

Engine Electrical System Maintenance

The engine electrical system incorporates computers to control certain functions of the equipment. The electrical system connections and ground circuits require good connections. Follow the recommended maintenance schedule in this section to maintain optimum performance. When inspecting the electrical system check the following:

• Check battery connection clean and insure that connectors are tight.

• Check battery for cracks or damage to the case replace if necessary.

• Check Positive and Negative cables for corrosion, rubbing, chaffing and insure tight connections at both ends.

• Check engine wire harness for rubbing, chaffing, pinching, and cracks or breaks in the wiring.

• Check engine harness connectors, check to insure fitted and locked by pushing the connector together then pull on the connector halves to insure they are locked.

• Check ignition coil wire for hardening, cracking, arcing, chaffing, separation, split boot covers and proper fit.

• Check spark plug wires for hardening, cracking, chaffing, separation, split boot covers and proper fit.

• Replace spark plugs at the required intervals per the recommended maintenance schedule

• Check to insure all electrical components are securely mounted and retained to the engine or chassis.

• Check to insure any additional electrical devices installed by the owner are properly installed in the system.

• Check the MIL, charging, and oil pressure lights for operation by starting the engine and checking that the light illuminates for the prescribe period of time before turning

out.

Engine Crankcase Oil

Oil Recommendation

Prior to changing the oil, select oil based on the prevailing daytime temperature in the area in which the equipment will be operated. The chart in figure 1 is a guide to selecting the proper crankcase oil.

IMPORTANT: Oils containing “solid” additives, non-detergent oils, or low quality oils are not recommended by the engine manufacturer.

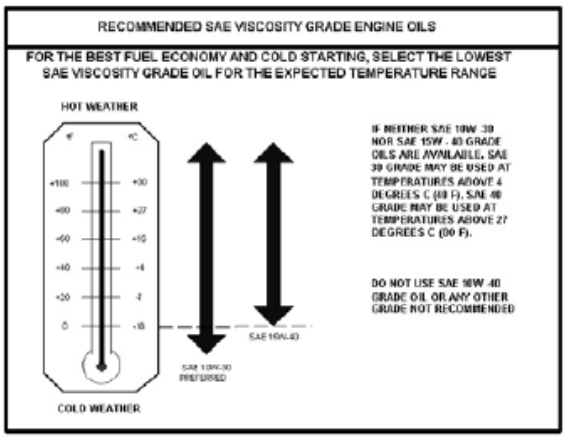


Figure 1 Engine Oil Viscosity Recommendation

Use of Supplemental Additives

Use of the oils recommended by the engine manufacturer already contains a balanced additive treatment.
The uses of supplemental additives which are added to the engine oil by the customer are not necessary and may be harmful. The engine manufacturer, fuels system suppliers and engine distributors do not review, approve or recommend such products.

Synthetic Oils

Synthetic oils have been available for use in industrial engines for a relatively long period of time.
Synthetic oils may offer advantages in cold temperature pumpability and high temperature oxidations resistance. However, synthetic oils have not proven to provide operational or economic benefits over conventional petroleum-based oils in industrial engines.
Their use does not permit the extension of oil change intervals.

Checking/filling Engine Oil Level

NOTE

Care must be taken when checking engine oil level.
Oil level must be maintained between the “ADD” mark and the “FULL” mark on the dipstick. To ensure that you are not getting a false reading, make sure the following steps are taken before checking the oil level.

1. Stop engine if in use

2. Allow sufficient time (approximately 5 minutes) for the oil to drain back into the oil pan

3. Remove the dipstick. Wipe with a clean cloth or paper towel and reinstall. Push the dipstick all the way into the dipstick tube.

4. Remove the dipstick and note the oil level.

5. Oil level must be between the “FULL” and “ADD” marks.

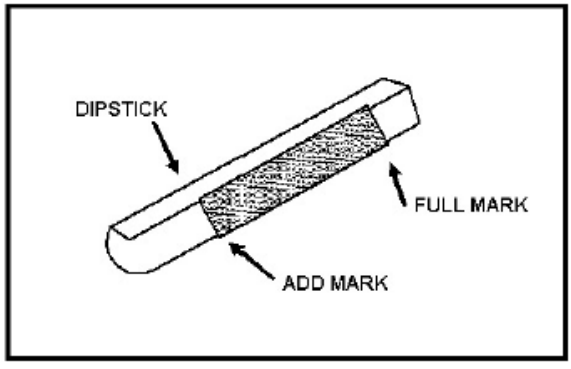


Figure 2 *Engine Oil Dip stick (Typical)*

6. If the oil level is below the “ADD” mark, proceed to Step 7 and 8, and reinstall the dipstick into the dipstick tube.

7. Remove the oil filler cap from the valve rocker arm cover

8. Add the required amount of oil to bring the level up to but not over the “FULL” mark on the

dipstick

9. Reinstall the oil filler cap to the valve rocker arm cover and wipe any excess oil clean.\

Changing the Engine Oil

NOTE

When changing the oil, always change the oil filter.

1. Start the engine and run until it reaches normal operating temperature.

NOTE

Change oil when engine is warm from operation as it flows more freely, carrying away more impurities.

2. Stop engine

⚠ WARNING

Engine oil will be hot. Use protective gloves to prevent burns. Engine oil contains chemicals which may be harmful to your health avoid skin contact.

3. Remove drain plug and allow the oil to drain.

4. Remove and discard oil filter and it sealing ring.

5. Coat sealing ring on the new filter with clean engine oil, wipe the sealing surface on the filter mounting surface to remove any dust, dirt or debris. Tighten filter securely (follow filter manufacturers instructions). Do not over-tighten.

6. Check sealing ring on drain plug for any damage, replace if necessary, wipe plug with clean rag, wipe pan sealing surface with clean rag and re-install plug into the pan. Tighten to specification.

7. Fill crankcase with oil.

8. Start engine and check for oil leaks.

9. Dispose of oil and filter in a safe manner.

Fuel System Inspection And Maintenance

Inspection and Maintenance Of The Fuel Storage Cylinder

The fuel storage cylinder should be inspected daily or at the beginning of each operational shift for any leaks, external damage, adequate fuel supply and to insure the manual service valve is open. Fuel storage cylinders should always be securely mounted, inspect the securing straps or retaining devices for damage insure that all locking devices are closed and locked. Check to insure that the fuel storage cylinder is positioned with the locating pin in the tank collar on all horizontally mounted cylinders this will insure the proper function of the cylinder relief valve.
When refueling or exchanging the fuel cylinder check the quick fill valve for thread damage. Insure the o-ring is in place, check the o-ring for cracking, chunking or separation, replace if damaged before filling.
Check the service line quick coupler for any thread damage. Insure the o-ring is in place, check the o-ring for cracking, hardening, chunking or separation.
Replace if damaged.

NOTE

When refueling the fuel cylinder, wipe clean both the female and male connection with a clean rag prior to filling. This will prevent dust, dirt and debris from being introduced to the fuel cylinder and prolong the life of the fuel filter.

Inspection and Replacement of The Fuel Filter

The Propane system on this emission certified engine utilizes an in-line replaceable fuel filter element.
This element should be replaced, at the

intervals specified in the recommended maintenance schedule.

When inspecting the fuel filter check the following:

• Check for leaks at the inlet and outlet fittings, using a soapy solution or an electronic leak detector, if leaks are detected make repairs

• Check to make sure filter is securely mounted.

• Check filter housing for external damage or distortion, if damaged replace fuel filter

To replace the filter use the following steps:

1. Move the equipment to a well ventilated area and insure all external ignition sources are not present.

2. Start the engine.

3. With the engine running close the manual valve.

4. When the engine runs out of fuel turn OFF the key when the engine stops and disconnect the battery negative cable.

⚠ WARNING

A small amount of fuel may still be present in the fuel line, use gloves to prevent burns, wear proper eye protection. If liquid fuels continues to flow from the connections when loosened check to make sure the manual valve is fully closed.

5. Slowly loosen the inlet fitting and disconnect.

6. Slowly loosen the outlet fitting and disconnect.

7. Remove the filter housing form the equipment.

8. Check for contamination.

9. Tap the opening of the filter on a clean cloth.

10. Check for debris.

11. Check canister for proper mounting direction.

12. Reinstall the filter housing to the equipment.

13. Tighten the inlet and outlet fittings to specification.

14. Open the manual valve.

NOTE

The fuel cylinder manual valve contains an "Excess Flow Check Valve" open the manual valve slowly to prevent activating the "Excess Flow Check Valve".

15. Check for leaks at the inlet and outlet fittings, and the filter housing end connection using a soapy solution or an electronic leak detector, if leaks are detected make repairs.

LPG Vaporizer Maintenance and Inspection

NOTE

The LPG Vaporizer (LV) components have been specifically designed and calibrated to meet the fuel system requirements of HHI. The regulator should not be disassembled or rebuilt. If the LV fails to operate or develops a leak the LV should be replaced with the OEM recommended replacement parts.

When inspecting the vaporizer check for the following items:

• Check for any fuel leaks at the inlet and outlet fittings.

• Check for any fuel leaks in the Vaporizer body.

• Check the inlet and outlet fittings of the coolant supply lines for water leaks.

• Check the coolant supply lines for hardening, cracking, chaffing or splits. If any of these conditions exist replace coolant lines.

• Check coolant supply hose clamp connections, ensure they are tight.

• Check the to ensure the LPG Solenoid Valve(LSV) mounting bolts are secure.

• Check LPG Solenoid Valve(LSV) electrical connection to ensure the connector is seated and locked.

• Check to ensure the Vaporizer is securely mounted.

Checking/draining Oil Build-up In The LPG Vaporizer

During the course of normal operation oil or "heavy ends" may build inside the secondary chamber of the LPG Vaporizer (LV). These oil and heavy ends may be a result of poor fuel quality, contamination of the fuel supply chain,

or regional variation of the fuel make up. If the buildup of oil becomes
Significant this can affect the performance of the secondary diaphragm response.
The Recommended Maintenance Schedule found in this section recommends that the oil be drained periodically.

NOTE

Draining the regulator when the engine is warm will help the oils to flow freely from the Vaporizer.

To drain the LV use the following steps:

1. Move the equipment to a well ventilated area and ensure no external ignition sources are present.

2. Start the engine.

3. With the engine running close the manual valve.

4. When the engine runs out of fuel turn OFF the key when the engine stops and disconnect the battery negative cable.

⚠ WARNING

A small amount of fuel may still be present in the fuel line, use gloves to prevent burns, wear proper eye protection. If liquid fuels continues to flow from the connections when loosened check to make sure the manual valve is fully closed.

5. Remove the LV Tar plug and retain on 10minute.

6. If remove the tar, reinstall the LV Tar plug.

7. Slowly open the manual service valve.

NOTE

The fuel cylinder manual valve contains an “Excess Flow Check Valve” open the manual valve slowly to prevent activating the “Excess Flow Check Valve”.

8. Check for leaks at the inlet and outlet fittings using a soapy solution or an electronic leak detector, if leaks are detected make repairs. Check coolant line connections to ensure no leaks are present.

9. Start engine recheck for leaks at the regulator.

10. Dispose of any drained material in safe and proper manner.

LPG Mixer/throttle Control Device Maintenance And Inspection

⚠ CAUTION

The LPG Mixer components have been specifically designed and calibrated to meet the fuel system requirements of the powered engine. The mixer should not be disassembled or rebuilt. If the mixer fails to operate or develops a leak the mixer should be replaced with the OEM recommended replacement parts.

When inspecting the mixer check for the following items:

• Check for any fuel leaks at the inlet fitting.

• Check the fuel inlet hose for cracking, splitting or chaffing, replace if any of these condition exist.

• Check to ensure the mixer is securely mounted.

• Check air inlet hose connection and insure clamp is tight, check inlet hose for cracking, splitting or chaffing, replace if any of these condition exist.

• Check air cleaner element according to the *Recommended Maintenance Schedule* found in this section.

• Check fuel line to Throttle body for cracking, splitting or chaffing, replace if any of these condition exist.

• Check Throttle body return action to ensure throttle shaft is not sticking repair if necessary.

• Check for leaks at the throttle body and intake manifold.

ENGINE MAINTENANCE REQUIREMENTS										
	Install	Interval Hours								
	Date	Daily	250	500	750	1000	1250	1500	1750	2000
General Maintenance Section										
Visual check for leaks		X								
Check engine oil level		X								
Check coolant level		X								
Change engine oil and filter	**Every 200 hours or monthly**									
Check Fuel system for leaks	**Prior to any service or maintenance activity**									
Inspect Accessory Drive belts						X				X
Inspect electrical system										X
Inspect all vacuum lines and fitting										X
Inspect all fuel lines and fitting										X
Engine Coolant Section										
Check coolant level		X								
Clean debris from radiator core	**Every 100 hours or 60 days of operation**									
Change coolant						X				X
Inspect coolant hoses for cracks, swelling or deterioration						X				X
Engine Ignition System										
Inspect Battery case for damage						X				X
Inspect battery cables						X				X
Check all electrical connectors						X				X
Check ignition timing and adjust										X
Replace spark plugs										X
Check ignition coil										X
Fuel System Maintenance										
Replace fuel filter						X				X
Inspect LSV for leaks										X
Ensure LSV closing										X
Test LPG/Gas vaporizer pressure										X
Remove tar(oil) of LV	**Annually or every 500 hours**									
Inspect LV for coolant leaks	**Annually or every 2000 hours**									
Check air induction system for leaks										X
Check manifold for vacuum leaks										X
Check LSV electrical connection										X
Check throttle shaft for sticking										X
Check injector & rails for leaks										X
Inspect air cleaner	**Every 200 hours, or every 100 hours in dusty environment**									
Replace filter element	**Annually, or Bi-annually in dusty environments**									
Engine Exhaust System										
Inspect exhaust manifold for leaks										X
Inspect exhaust piping for leaks										X

The maintenance schedule represents manufacturers recommended maintenance intervals to maintain proper engine/equipment function.

LPG FUEL SYSTEM OPERATION

LPG FUEL SYSTEM DIAGRAM

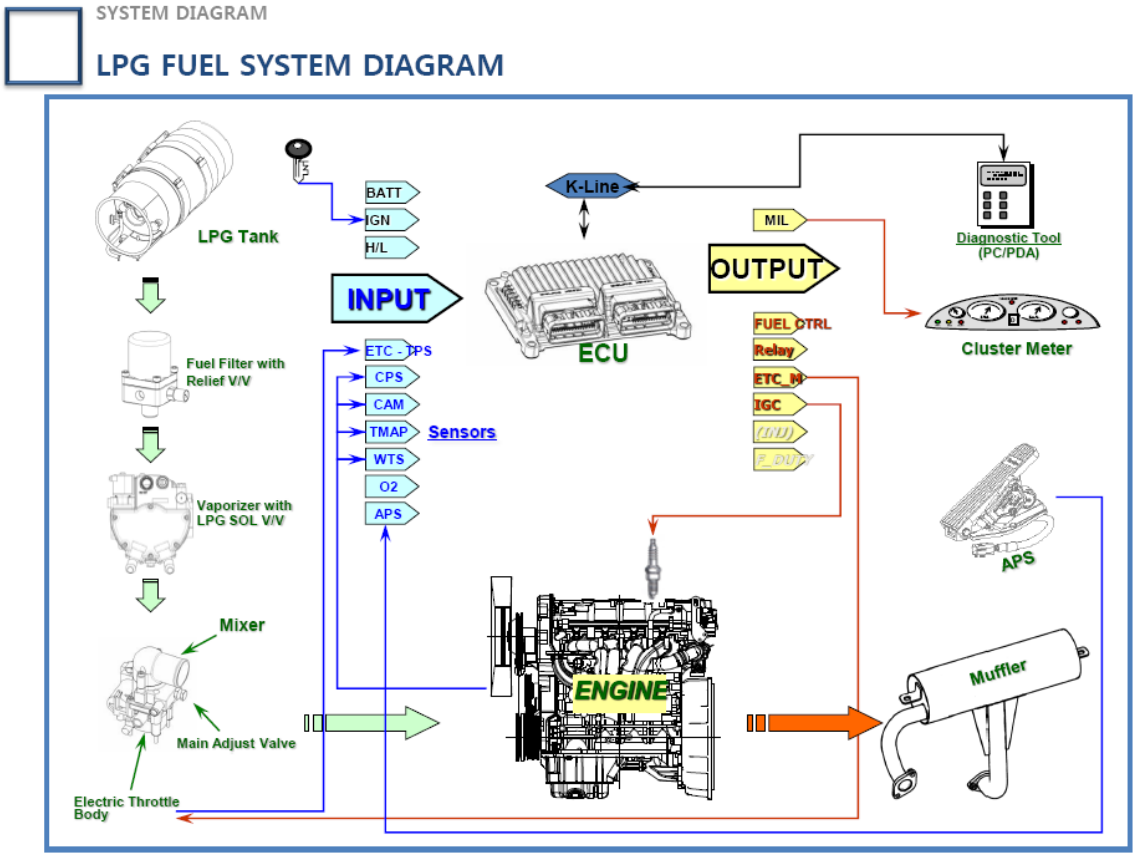


Figure 1 Fuel System Diagram

Description and Operation of the Fuel Systems

Propane Fuel System

The primary components of the propane fuel system are the fuel storage tank, LPG vaporizer with LPG solenoid valve(LV), LPG mixer module with throttle control device, engine control unit (ECM). The system operates at pressures which range from 2mm (0.08 inches) of water column up to 21.5 BAR (312psi).

LPG Fuel Tank

1.Liquid Outage valve w/quick disconnect coupling	11. Vapor Withdrawal Tube (when applicable)
2. Filler Valve	12. 80% Limiter Tube
3. Pressure Relief Valve	13. Fuel Level Float
4. Liquid Outage Fill Check Valve	14. Liquid Withdrawal Tube
5. Fuel Gauge	

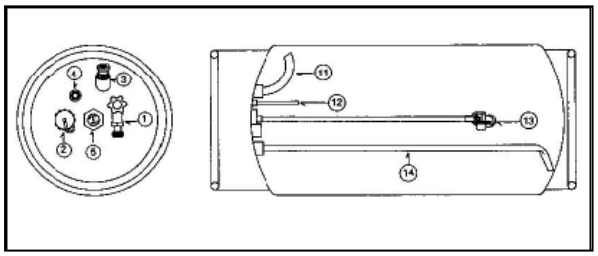


Figure 2 Typical Propane Fuel Tank

Propane is stored in the fuel tank as a liquid. The approximate pressure of the fuel in the tank is 16.5 bar (240 psi) when the tank is full at an ambient temperature of 27° C (81°F). The boiling point, (temperature at which the liquid fuel becomes vapor) is approximately -40° C (-40° F). When the fuel changes from liquid to vapor the fuel expands and creates pressure inside the tank. When the tank service valve is opened the pressure inside the tank forces the liquid fuel out though the pick up tube located near the bottom of the fuel cylinder. Because the propane is stored under pressure the tank is equipped with a safety valves which are normally
set at 25.8 bar (375 psi) to prevent tank rupture due to over-pressurization of the cylinder.
The service valve mounted in the end of the cylinder controls the flow of fuel from the tank. By turning the handle to its “open” position, fuel flows out of the tank and into the service line. The service valve is also equipped with a safety feature called an “excess flow check valve”. This feature reduces the flow from the service valve in the event of a rupture of the fuel line or any downstream component.

Service Line

Propane flows from the fuel tank to the electric lock via the service line. The service line is connected to the tank utilizing a quick coupler. The other end of the service line is connected to a “bulkhead connector” mounted on the equipment sheet metal. This bulkhead connector allows for a safe means of passing through the equipments engine compartment sheet metal and into the engine compartment. If a bulkhead connector is used a pressure relief device is mounted in the service line or the connector itself to prevent over pressurization of the service line. The service line is made of high pressure hose with special material or possibly tubing which is friendly to the LPG fuel and should always be replaced with an OEM supplied part.

⚠ CAUTION

The bulkhead assembly should never be removed and a service line run through the sheet metal.

Fuel Filter

Propane fuel like all other motor fuels is subject to contamination from outside sources. Refueling of the equipments tank and removal of the tank from the equipment can inadvertently introduce dirt and other foreign matter into the fuel system. It is therefore necessary to filter the fuel prior to entering the fuel system components downstream of the tank. An inline bulkhead fuel filter is utilized in the fuel system to remove the dirt and foreign matter from the fuel. The filter is replaceable. Maintenance of the filter is critical to proper operation of the fuel system and should be replaced as

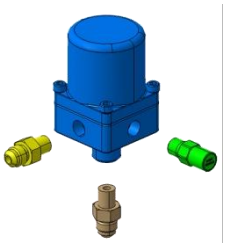


Figure 3 Inline Fuel Filter

defined in the Recommended Maintenance Schedule. In severe operating condition more frequent replacement of the filter may be necessary.

LPG Solenoid Valve(LSV)

The Electric Lock Off device is an integrated assembly. The electric lock assembly is a 12 volt normally closed valve.
The solenoid is mounted to the valve body. When energized the solenoid opens the valve and allows the Propane fuel to flow through the device. The valve opens during cranking and run cycles of the engine. The Solenoid valve supply voltage is controlled by the engine module (ECM)

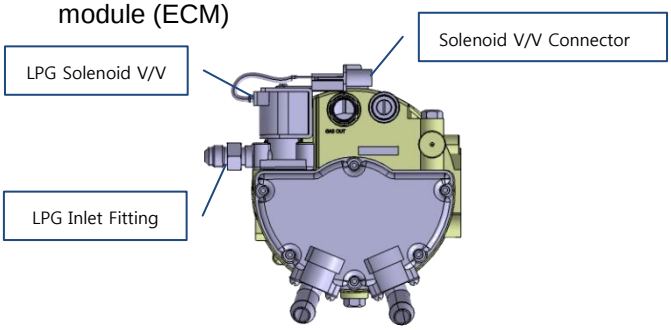


Figure 4 LPG Solenoid Valve

LPG Vaporizer(LV)

The LV is a combination vaporizer, pressure regulating device. The LPR is a negative pressure two stage regulator that is normally closed when the engine is not running. When the engine is cranking or running a partial vacuum is created in the fuel line which connects the regulator to the mixer. This partial vacuum opens the regulator permitting fuel to flow to the mixer.
Propane fuel enters the primary port of the LPR and passes through the primary jet and into the primary/exchanger chamber. As the propane passes through the heat exchanger the fuel expands and creates pressure inside the chamber.
The pressure rises as the fuel expands when the pressure rises above 39 kpa (5.7psi), sufficient pressure is exerted on the primary diaphragm to cause the diaphragm plate to pivot and press against the primary valve pin thus closing off the flow of fuel. This action causes the flow of fuel into the regulator to be regulated.
When the engine is cranking, sufficient vacuum will be introduce into the secondary chamber from the mixer drawing the secondary diaphragm down onto the spring loaded lever and opening the secondary valve allowing vaporized fuel to pass to the mixer. Increased vacuum in the secondary chamber increases the downward action on the secondary lever causing it to open wider allowing more fuel to flow to the mixer.

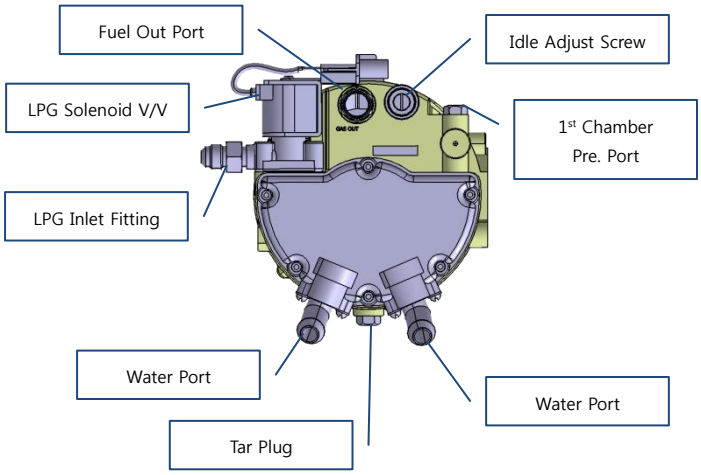


Figure 5 LPG Vaporizer

⚠ CAUTION

The LV is an emission control device. Components inside the regulator are specifically calibrated to meet the engine emissions requirements and should never be disassembled or rebuilt. If the LV fails to operate, replace with an OEM replacement part.

⚠ CAUTION

When servicing the regulator use caution to insure the jet is replaced in the vaporizer. Failure to install the jet may cause damage to the regulator and cause fuel control and emission problems. The process of pressure reduction within the regulator causes a

refrigeration effect this requires that the vaporizer be heated with engine coolant to prevent the regulator from freezing and fail to function properly.
The vaporizer is connected into the coolant system by hoses connected to the engines coolant circuit. The emission certified regulator contains an orifice or jet in the outlet side of the regulator to maintain the proper amount of coolant flow during regular operation. The orifice is located between the inlet fitting and the housing of the vaporizer.

LPG Mixer
The air valve mixer is an air-fuel metering device and is completely self-contained.
The mixer is a static venturi design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device.

⚠ CAUTION

The air/fuel mixer is an emission control device. Components inside the mixer are specifically calibrated to meet the engines emissions requirements and should never be disassembled or rebuilt. If the mixer fails to operate replace with an OEM replacement part.

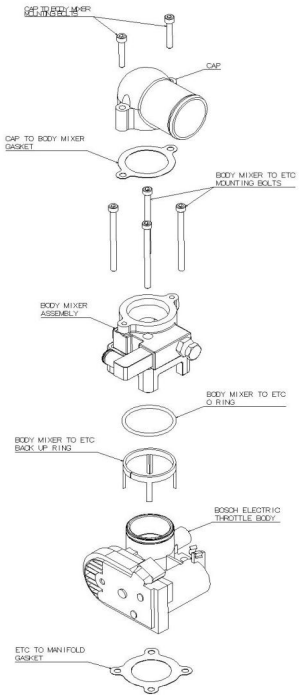


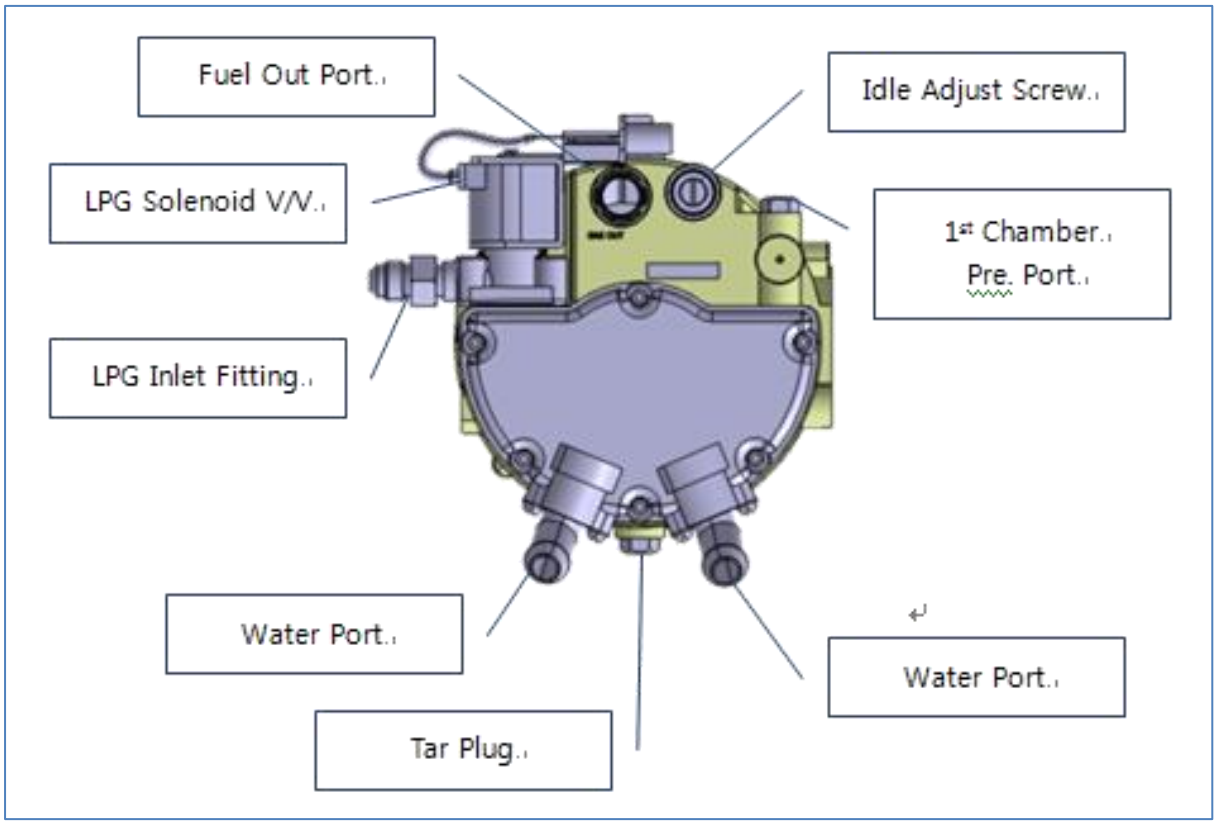
Figure 6 LPG Mixer & Throttle Cotrol Device

When the engine begins to crank it, the mixer venturi generate negative pressure.
The venturi`s function is to supply gas mixed the fuel and air to engine.

The mixer is equipped with a low speed mixture adjustment which is retained in a tamper proof housing. The mixer has been preset at the factory and should not require any adjustment. In the event that the idle adjustment should need to be adjusted refer to the Fuel System Repair section of this manual.

Throttle Control Device
Drive By Wire Engine speed control is maintained by the amount of pressure applied to the foot pedal located in the engine compartment. In a Drive By Wire (DBW) application there is no direct connection between the operator pedal and the throttle shaft. Speed and load control are determined by the ECM.
Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine.
In a drive by wire application the Electronic Throttle Control device or “throttle body assembly” is connected to the intake manifold of the engine.
The electronic throttle control device utilizes an electric motor connected to the throttle shaft.
In addition a Foot Pedal Position sensor (FPP) is located in the operator’s compartment.
When the engine is running electrical signals are sent from the foot pedal position sensor to the engine ECM when the operator depresses or release the foot pedal. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel charge to the engine.
The electronic throttle control device incorporates two internal Throttle Position Sensors
(TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade.
The TPS information is used by the ECM to correct for speed and load control as well as emission control.

LPG FUEL SYSTEM DIAGNOSTICS



LPG Fuel System Diagnosis

Fuel System Description

LPG is stored in the tank and delivered under pressure to the system as a liquid. During key on, the LSV receives a two (2) second prime pulse from the ECM which allows LPG to flow from the tank through fuel filter and fuel lines to the LPG Vaporizer (LV) at pressures up to 312 psi.

In the (LV) the fuel is vaporized and the pressure reduced in two stages. The first stage reduces the pressure to approximately 5.8 psi. The second stage reduces the pressure to approximately negative 0.08" of water column.

In the mixer, the fuel mixes with the air entering the engine. This air/fuel mixture is then drawn into the engine for combustion.

Diagnostic Aids

This procedure is intended to diagnose a vehicle operating on LPG.If the vehicle will not continue to run on LPG, refer to Hard Start for preliminary checks. Before proceeding with this procedure, verify that the vehicle has a sufficient quantity of fuel and that liquid fuel is being delivered to the LPR. Also, ensure that the manual shut off valve on the LPG tank is fully opened and that the excess flow valve has not been activated.

Tools Required:

- 13mm Open end wrench (for test port plugs)
- Straight Blade screw driver
- Diagnostic Scan Tool(EXVIPER & XCTU)
- Multi Meter
- Pressure Gauge(0~1barG)

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Step	Action	Value	Yes	No
1	Were you referred to this procedure by a DTC diagnostic chart?	-	Go to step3	Go to step2
2	Perform the On Board Diagnostic (OBD) System Check. Are any DTCs present in the ECM?		Go to the applicable DTC Table	Go to *Step3*
3	Verify that the LPG fuel tank has a minimum of 1/4 tank of fuel, that the manual valve is open and the tank quick connect is fully engaged Does the vehicle have fuel?		Go to *Step4*	
4	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LV and mixer assembly for damage or leakage. Was a problem found and corrected?		Go to *Step21*	Go to *Step5*
5	1. Remove Air induction hose to the mixer 2. Check the mixer's venturi. Did mixer' venturi pollution?		Go to *Step 7*	Go to *Step 6*
6	Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. Was a problem found and repaired?		Go to *Step 21*	Go to *Step 20*
7	Inspect the fuel hose connection between the LV and the mixer assembly for damage or leakage. Must be cleaning the mixer's vuturi. Was a problem found and repaired?		Go to *Step 21*	Go to *Step 8*
8	1. Connect a 0-1barG gauge to the primary test port of the LPG Vaporizer (LV). 2. Crank the engine and observe the pressure reading for the LV 1st chamber pressure. Is the fuel pressure **ABOVE** the specified value?	0.31 ~0.48barG	Go to *Step 18*	Go to *Step 9*
9	1. Turn OFF the ignition. 2. Disconnect the LSV connector. 3. Install a test light between the pins of the LSV connector. 4. Crank the engine. The test light should illuminate.		Go to *Step 10*	Go to *Step 12*

	Does the test light illuminate?			
10	Using a multi meter, check the resistance of the LPG Solenoid Valve (LSV). Is the resistance within the specified range?	12~24Ω	Go to *Step 11*	Go to *Step 19*
11	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. **CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area.** 3. Loosen the fuel inlet hose fitting at the inlet of the LVS. Was fuel present when the fitting was loosened?		Go to *Step 19*	Go to *Step 13*
12	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LSV connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?		Go to *Step 16*	Go to *Step 17*
13	1. Remove the LPG fuel filter 2. Empty the contents of the inlet side of the LPG fuel filter onto a clean surface. 3. Inspect the contents of the LPG fuel filter for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. 4. Verify the LPG fuel filter is not restricted or plugged. Was a problem found?		Go to *Step 15*	Go to *Step 19*
14	The fuel supply system or hoses are plugged or restricted, locate and repair the problem. Is the action complete?		Go to *Step 21*	
15	Replace the fuel filter. Refer to *Fuel Filter Replacement.* Is the action complete?		Go to *Step 21*	
16	Repair the open in the LSV power ground circuit. Is the action complete?		Go to *Step 21*	
17	Repair the open in the LSV power (OEM fuel pump) circuit.		Go to *Step 21*	

	Is the action complete?			
18	Replace the LPG Vaporizer (LV). Refer to *LPG Vaporizer Replacement*. Is the action complete?		Go to *Step 21*	
19	Replace the LPG Solenoid Valve. Is the action complete?		Go to *Step 21*	
20	Replace the mixer assembly. Refer to *Fuel Mixer Replacement*. Is the action complete?		Go to *Step 21*	
21	1. Disconnect all test equipment 2. Install the primary and secondary test port plugs. 3. Start the engine. 4. Using SNOOP® or equivalent, leak check the test port plugs. Is the action complete?		System OK	

SYMPTOM DIAGNOSIS

Symptom Diagnosis

Important Preliminary Checks

Checks	Action
Before Using This Section	Before using this section, you should have performed On Board Diagnostic Check and determined that: 1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly. 2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL. Several of the following symptom procedures call for a careful Visual and physical check. The visual and physical checks are Very important. The checks can lead to correcting a problem Without further check that may save valuable time.
LPG Fuel System Check	1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom. 4. Operate the vehicle under the conditions the symptom occurs. 5. If a scan tool is available, **take a snapshot** under the condition that the symptom occurs. Go to Engine Scan Tool Data List to verify normal sensor values and parameters.

Visual and Physical Checks	• Check all ECM system fuses and circuit breakers. • Check the ECM ground for being clean, tight and in its proper location. • Check the vacuum hoses for splits, kinks and proper connections. • Check thoroughly for any type of leak or restriction. • Check for air leaks at all the mounting areas of the intake Manifold sealing surfaces. • Check for proper installation of the mixer module assembly. • Check for air leaks at the mixer assembly. • Check the ignition wires for the following conditions: - Cracking - Hardness - Proper routing - Carbon tracking • Check the wiring for the following items: - Proper connections, pinches or cuts. • The following symptom tables contain groups of possible Causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.

Intermittent

Checks	Action
DEFINTION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or Store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	• Refer to Important Preliminary Checks. • Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	• Faulty electrical connections or wiring can cause most Intermittent problems. • Check the suspected circuit for the following conditions: - Faulty fuse or circuit breaker - connectors poorly mated - Terminals not fully seated in the connector (backed out) - Terminals not properly formed or damaged - Terminal to wires poorly connected - Terminal tension insufficient. • Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. • Checking for poor terminal to wire connections requires Removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the Problem, drive the vehicle with a scan tool. When the problem Occurs, an abnormal voltage or scan reading indicates the Problem may be in that circuit.
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no ETC(s): • A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. • The improper installation of electric devices, such as lights, 2-way radios, electric motors, etc. • The ignition secondary voltage shorted to a ground. • The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. • The Control Module grounds.

Loss of DTC Memory	To check for the loss of the DTC Memory 1. Disconnect the TMAP sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates. The ECM should store a TMAP DTC. The TMAP DTC should remain in the memory when the ignition is turned OFF. If the TMAP DTC does not store and remain, the ECM is faulty.
Additional Checks	.

No Start

Checks	Action
DEFINTION: The engine cranks OK but does not start.	
Preliminary Checks	• Refer to Important Preliminary Checks.
	• If a scan tool is available: • Check for proper communication with both the ECM • Check the 3A inline fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. • Check battery power, ignition power and ground circuits to The ECM, Refer to Engine Control Schematics. Verify voltage And/or continuity for each circuit.
Sensor Checks	• Check the TMAP sensor. • Check the Magnetic pickup sensor (RPM).
Fuel System Checks	**Important**: A closed LPG manual fuel shut off valve will create a No start condition. • Check for air intake system leakage between the mixer and The throttle body. • Verify proper operation of the low pressure lock-off solenoids. • Verify proper operation or the fuel control solenoids. • Check the fuel system pressures. Refer to the LPG fuel System Diagnosis. • Check for proper mixer air valve operation.

Ignition system Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for the proper ignition voltage output with The equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits • Check foe bare or shorted ignition wires. • Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	**Important:** The LPG Fuel system works on a fumigation Principle of fuel introduction and is more sensitive to intake Manifold leakage than the gasoline fuel supply system. • Check for the following: - Vacuum leaks - Improper valve timing - Low compression

	- Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes.
Exhaust System Checks	• Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for Possible internal failure.

Hard Start

Checks	Action
DEFINTION: The engine cranks OK, but does not start for a long time. The engine does Eventually run, or may start but immediately dies.	
Preliminary Checks	• Refer to Important Preliminary Checks. • Make sure the vehicle's operator is using the correct starting Procedure.
Sensor Checks	• Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111 • Check the Crankshaft Position (CKP) sensor. • Check the Throttle position (TPS) sensor.
Fuel System Checks	**Important**: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. • Verify the excess flow valve in the LPG manual shut-off valve is not tripped. • Check mixer module assembly for proper installation and leakage. • Verify proper operation of the LPG solenoid valve. • Check for air intake system leakage between the mixer and the throttle body. • Check the fuel system pressures. Refer to the Fuel System Diagnosis.

Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for the proper ignition voltage output with the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits • Check for bar or shorted ignition wires. • Check for moisture in the distributor cap if applicable. • Check for loose ignition coil connections. **Important:** 1. If the engine starts but then immediately stalls, Crankshaft Position(CKP) 2. Check for improper gap, debris or faulty connections.

Engine Mechanical Checks	**Important:** The LPF Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes. Ref • Check the intake and exhaust manifolds for casting flash.

Exhaust System Checks	• Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure.
Additional Checks	•

Cuts Out, Misses

Checks	Action
DEFINTION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	• Refer to Important Preliminary Checks.
Ignition System Checks	• Start the engine. • Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. • Check for the proper ignition output voltage with spark tester. • Check for a cylinder misfire. • Verify that the spark plugs are correct for use with LPG • Remove the spark plugs in these cylinder and check for the following conditions: • Insulation cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Visually/physically inspect the secondary ignition for the following: • Ignition wires for arcing, cross-firing and proper routing • Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	• Perform a cylinder compression check. • Check the engine for the following: - Improper valve timing - Bent pushrods - Worn rocker arms - Worn camshaft lobes. - Broken or weak valve springs. • Check the intake and exhaust manifold passages for casting flash.

Fuel System Checks	• Check the fuel system – plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. • Check the condition of the wiring to the low pressure lock-off solenoid.

Additional Check	Check for Electromagnetic Interference (EMI). • EMI on the reference circuit can cause a missing condition. • Monitoring the engine RPM with a scan tool can detect an EMI. • A sudden increase in the RPL with little change in the actual engine RPM, indicates EMI is present. • If the problem exists, check the routing of the secondary wires and the ground circuit.

Hesitation, Sag, Stumble

Checks	Action
DEFINTION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severs enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	• Check the fuel pressure. Refer to LPG Fuel System Diagnosis. • Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. • Check the Manifold Absolute pressure (MAP)sensor response and accuracy. • Check LSV electrical connection • Check the mixer air valve for sticking or binding. • Check the mixer module assembly for proper installation and leakage.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly. • Check for the proper ignition voltage output with the equivalent. • Verify that the spark plugs are correct for use with LPG • Check for faulty spark plug wires • Check for fouled spark plugs.
Additional Check	1. Check for manifold vacuum or air induction system leaks • Check the generator output voltage.

Backfire

Checks	Action
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	• Refer to Important Preliminary Checks.
Ignition System Checks	**Important!** **LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire.** • Check for the proper ignition coil output voltage using the spark tester the equivalent. • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. • Check the connection at each ignition coil. • Check for deteriorated spark plug wire insulation. • Check the spark plugs. The correct spark plugs for LPG engine. • Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits

Engine Mechanical Check	**Important!** **The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system.** • Check the engine for the following: - Improper valve timing - Engine compression - Manifold vacuum leaks - Intake manifold gaskets - Sticking or leaking valves - Exhaust system leakage • Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	• Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.

Lack of Power, Sluggishness, or Sponginess

Checks	Action
DEFINTION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	• Refer to Important Preliminary Checks. • Refer to LPG Fuel system OBD System Check • Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics • Remove the air filter and check for dirt or restriction. • Check the vehicle transmission Refer to the OEM transmission diagnostics.
Fuel System Checks	• Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG fuel System Diagnosis. • Check for the proper ignition output voltage with the spark tester the equivalent. • Check for proper installation of the mixer module assembly. • Check all air inlet ducts for condition and proper installation. • Check for fuel leaks between the LV and the mixer. • Verify that the LPG tank manual shut-off valve is fully open. • Verify that liquid fuel (not vapor) is being delivered to the LV.
Sensor Checks	• Check for proper operation the MAP sensor. • Check for proper operation of the TPS sensor.
Exhaust System Checks	• Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure.

Engine Mechanical Check	Check the engine for the following: • Engine compression • Valve timing • Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • If all procedures have been completed and no malfunction has been found, review and inspect the following items: • Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. • Check the scan tool data.

Poor Fuel Economy

Checks	Action
DEFINTION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an by refueling records.	
Preliminary Checks	• Refer to Important Preliminary Checks. • Check the air cleaner element (filter) for dirt or being plugged. • Visually (physically) check the vacuum noses for splits, kinks, and proper connections. • Check the operators driving habits for the following items: - Is there excessive idling or stop and go driving? - Are the tire at the correct air pressure? - Are excessively heavy loads being carried? - Is their often rapid acceleration? • Suggest to the owner to fill the fuel tank and to recheck the fuel economy. • Suggest that a different operator use the equipment and record the results.
Fuel System Checks	• Check LV fuel pressure. Refer LPG Fuel System Diagnosis. • Check the fuel system for leakage.
Sensor Checks	• Check the Temperature Manifold Absolute Pressure (TMAP) sensor.
Exhaust System Checks	• Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits • Check the ignition wires for the following items: - Cracking - Hardness - Proper connections
Cooling System Checks	• Check the engine thermostat for always being open of for the wrong heat range

Additional Check	• Check the transmission shift pattern. Refer to the OEM Transmission Control section the Service Manual. • Check for dragging brakes.

Rough, Unstable, or Incorrect Idle, Stalling

Checks	Action
DEFINTION: The engine runs unevenly at idle. If severs enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Checks	• Refer to Important Preliminary Checks.
Sensor Checks	• Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe drive ability problem. • Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	• Check for rich of lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check for a sticking mixer air valve. • Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. • Check the LV fuel pressure. Refer to the LPG Fuel System Diagnosis. • Check mixer module assembly for proper installation and connection.

Ignition System Checks	• Check for the proper ignition output voltage using the spark tester the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Blistered insulators - Heavy deposits • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	Important: The LPG fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check foe vacuum leaks. Vacuum leaks can cause a higher

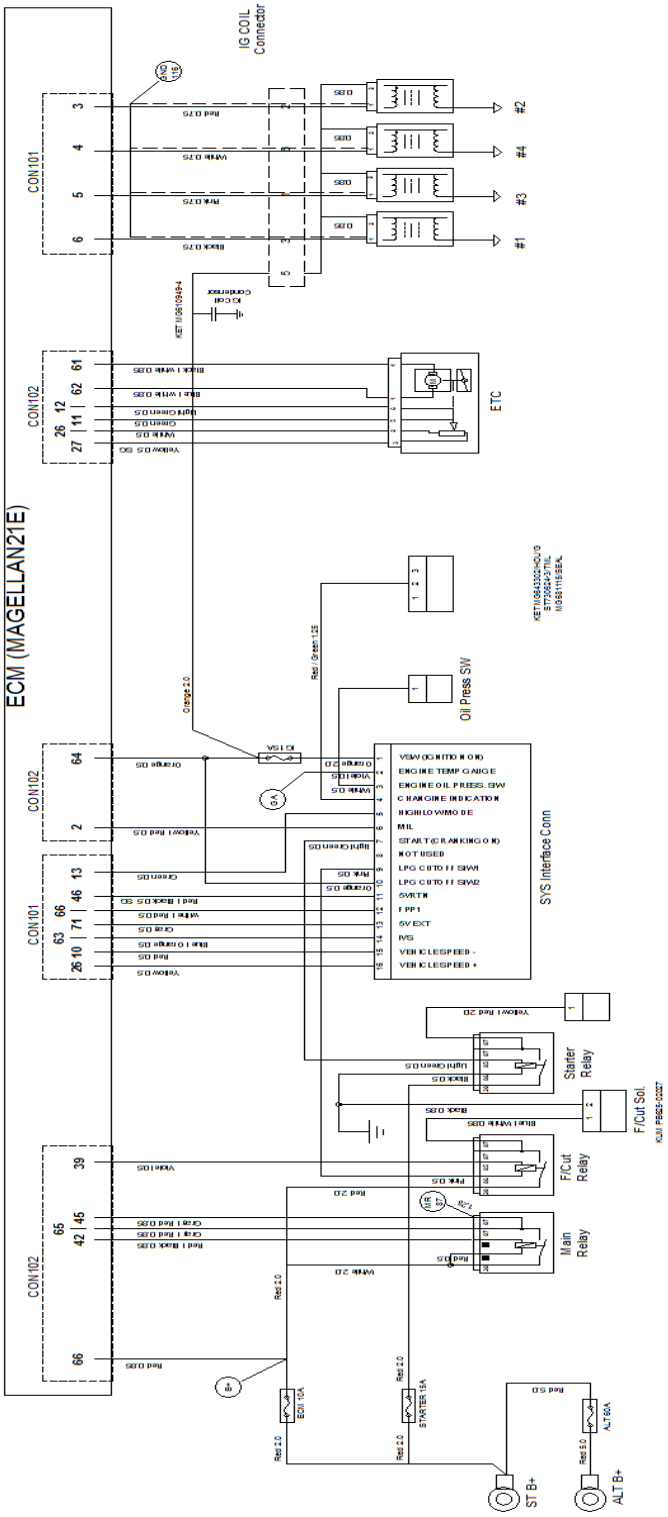
	than normal idle and low throttle angle control command. • Check the ECM grounds for being clean, tight, and in their proper locations. • Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality
Engine Mechanical Check	• Check the engine for the following: - Broken motor mounts - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken of weak valve springs - Worn camshaft lobes

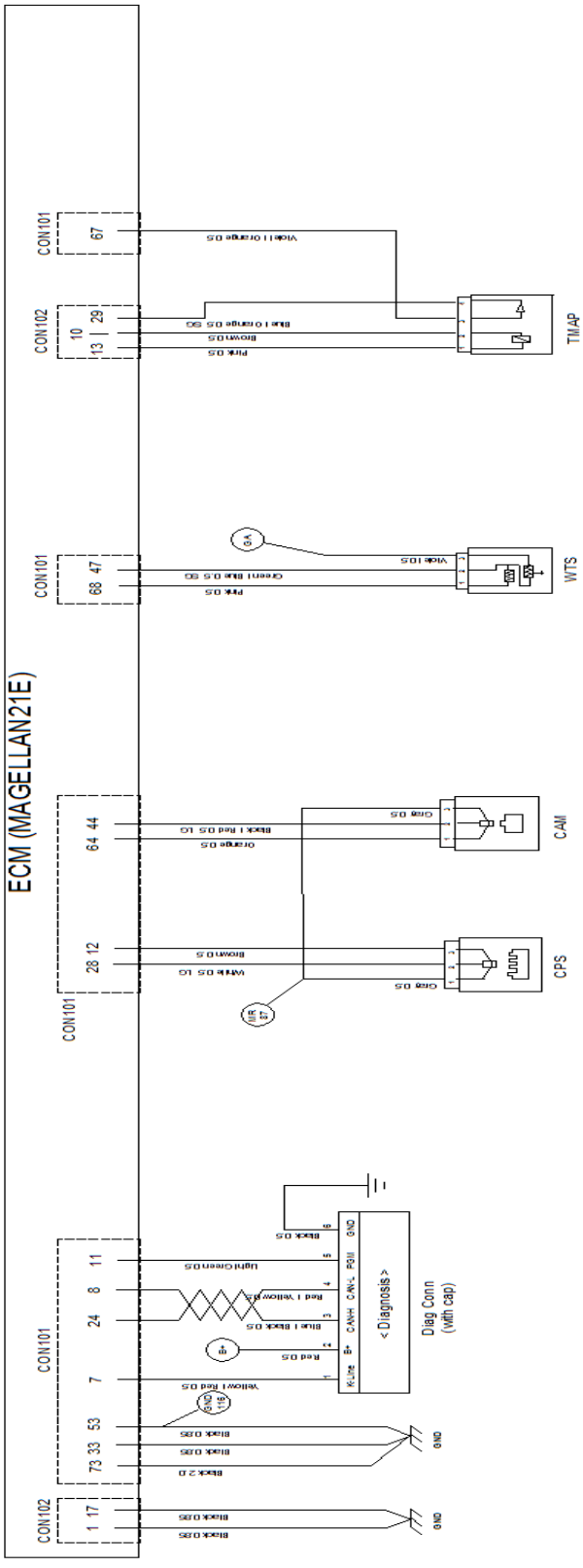
Surges/Chuggles

Checks	Action
DEFINTION: The engine has a power variation under throttle or cruise. The vehicle feels as if it speed up and slows down with no change in the accelerator pedal.	
Preliminary Checks	• Refer to Important Preliminary Checks. • Be sure the driver understands the Torque Converter Clutch operation.
Fuel System Checks	• Check for rich of lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. • Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. • Verify proper fuel control solenoid operation. • Verify that the LPG manual shut-off valve is fully open. • Check the in-line fuel filter for restrictions.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester of the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits - Check the Crankshaft Position (CKP) sensor.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • Check the vacuum hoses for kinks or leaks. • Check Transmission

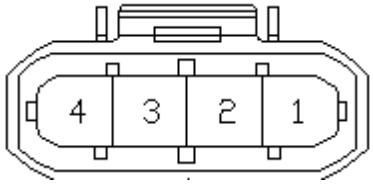
WIRING SCHEMATICS

MAIN WIRING HARNESS



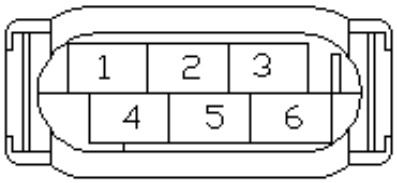

ECM (MAGELLAN21E)
CON101
CON102
67
29
10
13
47
68
64
44
28
12
11
8
24
7
53
33
73
1
17
TMAP
WTS
CAM
CPS
Diag Conn
(with cap)
< Diagnosis >
GND

TMAP CONNECTOR



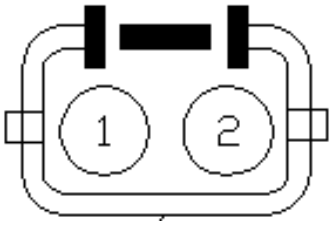
Pins	Wire Color	Function
1	Pink	Manifold Air Pressure sensor Input
2	Brown	5V supply 1.2 Power
3	Violet/Orange	Air Temperature sensor Input
4	Blue/Orange	Sensor Ground: TMAP Ground

ETC CONNECTOR



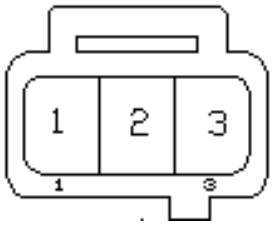
Pins	Wire Color	Function
1	Blue/White	ETC motor drive (-) Output
2	White	5V supply 1.1 Power
3	Yellow	Sensor ground: TPS1 Ground
4	Black/White	ETC motor drive (+) Output
5	Green	Throttle position sensor Input
6	Light Green	Throttle position sensor Input

FUEL CUT SOL CONNECTOR



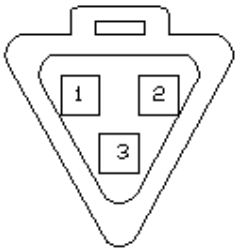
Pins	Wire Color	Function
1	Blue/White	12V
2	Black	Ground

CAM CONNECTOR



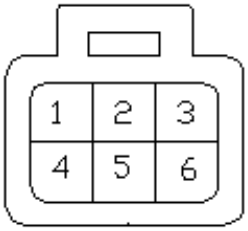
Pins	Wire Color	Function
1	Orange	Camshaft Position sensor(Hall sensor) Input
2	Black/Red	Sensor ground: CAM Ground
3	Gray	12V

WTS CONNECTOR



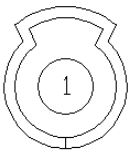
Pins	Wire Color	Function
1	Pink	Engine Coolant Temperature sensor Input
2	Green/Blue	Sensor ground: WTS Ground
3	Violet	Engine Temperature Gauge

IGNITION COIL CONNECTOR



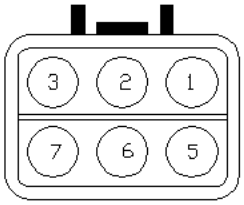
Pins	Wire Color	Function
1	Pink	Ignition Coil 2 Output
2	Red	Ignition Coil 4 Output
3	Black	Ignition Coil 1 Output
4	-	-
5	Orange	12V
6	White	Ignition Coil 3 Output

OIL PRESSURE SW CONNECTOR



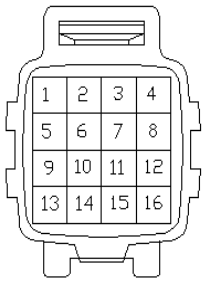
Pins	Wire Color	Function
1	White	Engine Oil Pressure Switch

DIGNOSTIC CONNECTOR



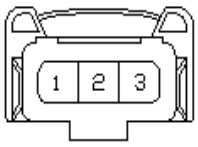
Pins	Wire Color	Function
1	Yellow/Red	KWP2000 data communication line I/O
2	Red	12V
3	Blue/Black	CAN communication H I/O
4	Red/Yellow	CAN communication L I/O
5	Light Green	Program Enable port Input
6	Black	Ground

SYSTEM INTERFACE CONNECTOR



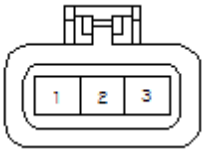
Pins	Wire Color	Function
1	Orange	VSW
2	Violet	Engine Temperature Gauge
3	White	Engine Oil Pressure Switch
4	Red/Green	Alternator Charge Indication
5	Green	High/Low Mode
6	Yellow/Red	MIL
7	Light Green	Start(Cranking On)
8	-	-
9	Pink	LPG Cut Off SW1
10	Orange	LPG Cut Off SW2
11	Red/Black	5V RTN(Sensor Ground)
12	White/Red	FPP1(Pedal Signal)
13	Gray	5V EXT(Sensor Voltage 5V)
14	Blue/Orange	IVS(Idle validation SW Input)
15	Red	Vehicle speed sensor Input (-)
16	Yellow	Vehicle speed sensor Input (+)

CPS CONNECTOR



Pins	Wire Color	Function
1	Gray	12V
2	White	Sensor ground: HCPS
3	Brown	Engine speed sensor (Hall type) Input

AL TERNATOR CONNECTOR



Pins	Wire Color	Function
1	-	-
2	Red/Green	Alternator Charge Incator
3	-	-

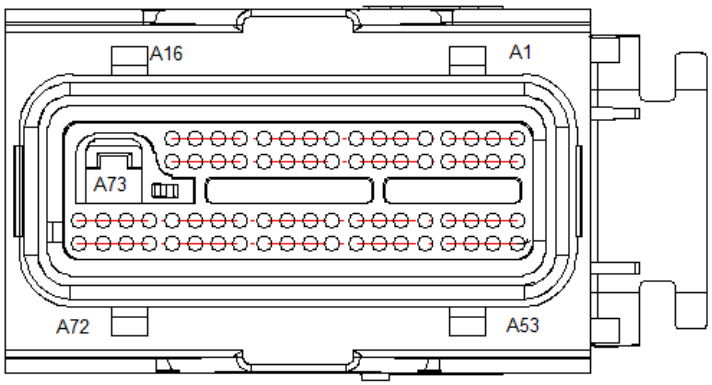
BATTERY START SOL

Pins	Wire Color	Function
1	Red	12V

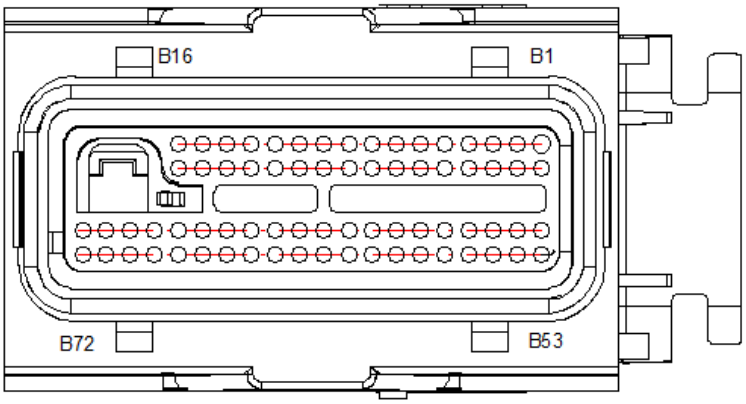
BATTERY ALT

Pins	Wire Color	Function
1	Red	12V

ECM CONNECTOR 101



ECM CONNECTOR 102



DIAGNOSTIC TROUBLE CODES

1. Introduction

: Normally, engine management unit (ECU) collects the sensor value informations to optimize engine operation.

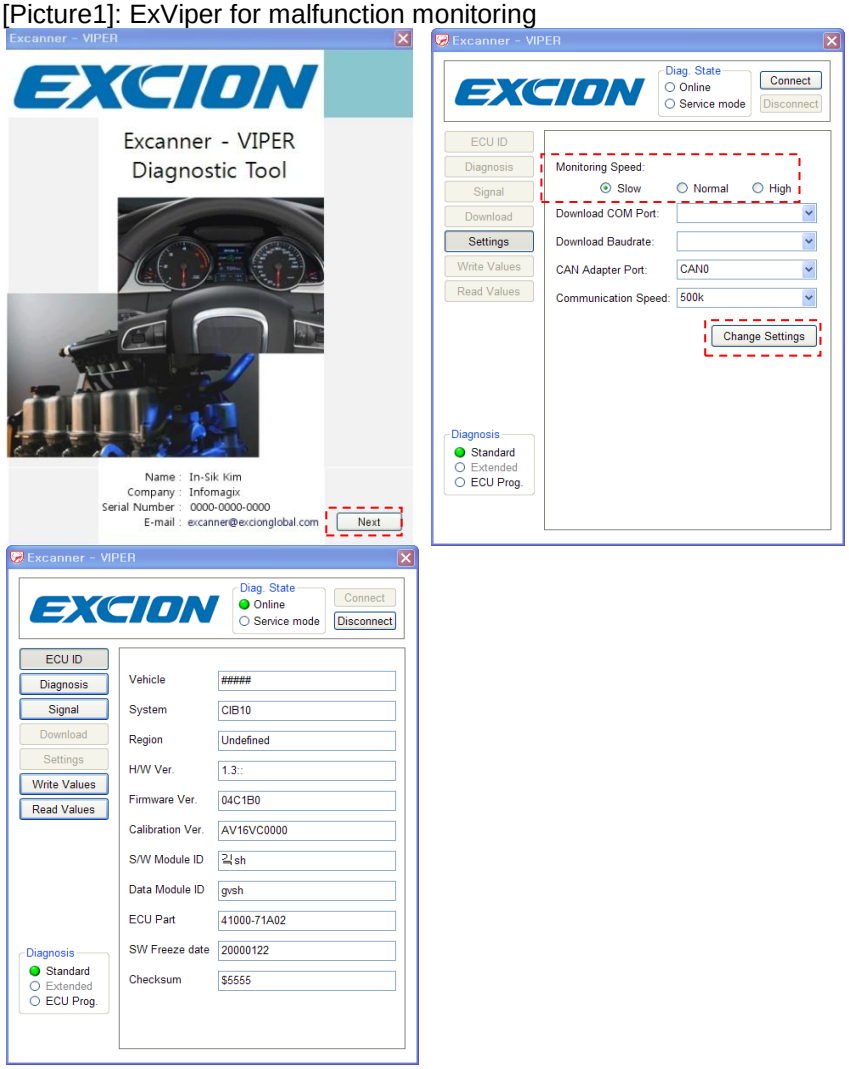
So every engine sensors have their own diagnosis function to monitor sensor voltage and detect error condition.

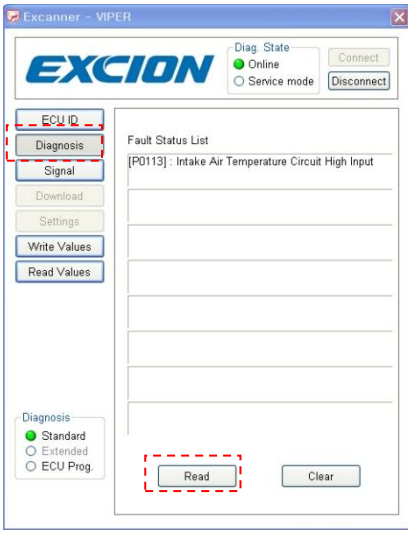
If sensor detects error conidtion during engine opeation, error information will be deliveried to error corrdintion function to enable malfunction lamp.

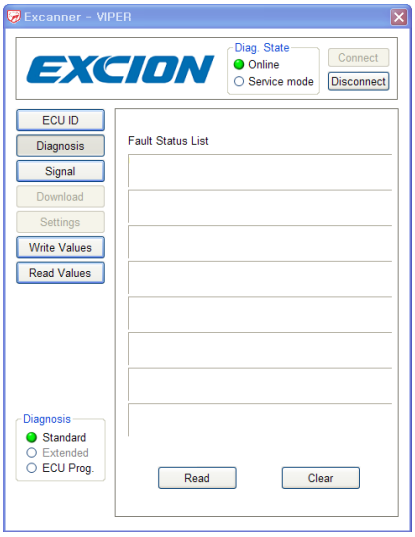
1.1 SCAN Tool_ExViper

: Viper is used to set desired vehicle speed up and monitor malfunction P-Code for diagnosis

[Picture1]: ExViper for malfunction monitoring







Please refer to detail information from SCAN tool ueser guide.

1.1 OBDI PID Information

[Table1]: P-Code Information

Manifold Pressure Sensor	P0106	MAP SENSOR - Manifold Absolute Pressure/Barometric Pressure Circuit Range/Performance
	P0107	MAP SENSOR - Manifold Absolute Pressure/Barometric Pressure Circuit Low Input
	P0108	MAP SENSOR - Manifold Absolute Pressure/Barometric Pressure Circuit High Input
Intake air temperature sensor	P0112	Intake Air Temperature Circuit Low Input
	P0113	Intake Air Temperature Circuit High Input
Engine Coolant Temperature sensor	P0116	Engine Coolant Temperature Circuit Range / Performance
	P0117	Engine Coolant Temperature Circuit Low Input
	P0118	Engine Coolant Temperature Circuit High Input
Throttle Position sensor	P2135	TPS - Throttle Position Sensor Voltage Correlation
	P0122	TPS1 - Throttle Position Circuit Low Input
	P0123	TPS1 - Throttle Position Circuit High Input
	P0222	TPS2 - TPS Circuit Low Input
	P0223	TPS2 - TPS Circuit High Low

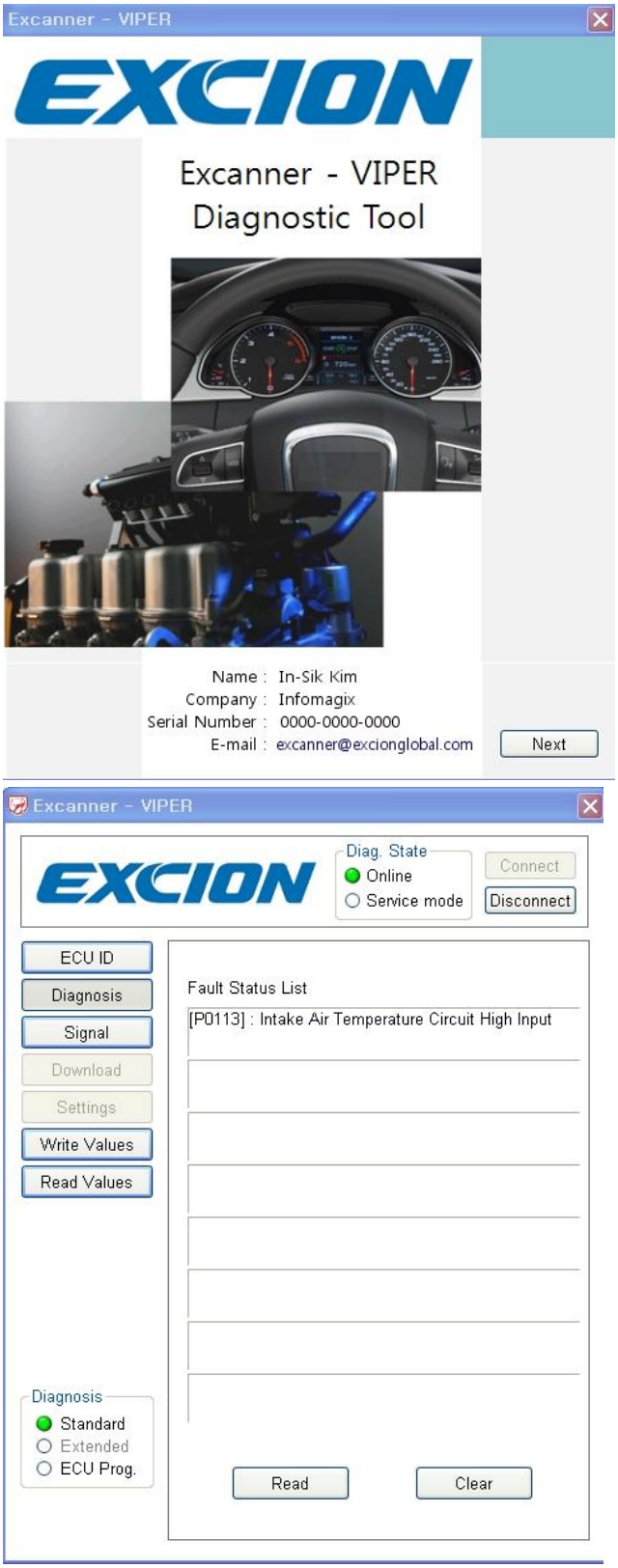
Crankshaft Position sensor	P0335	Crankshaft Position Sensor Circuit Malfunction
	P0336	CKP SENSOR (CPS) - Crankshaft Position Sensor Circuit Range/Performance
	P0337	Crankshaft Position Sensor Circuit Low
	P0338	Crankshaft Position Sensor Circuit High
Camshaft poistion sensor	P0340	Camshaft Position Sensor Circuit Malfunction(Bank1 or Single Sensor)
	P0341	Camshaft Position Sensor Circuit Range/Performance(Bank1 or Single)
	P0342	Camshaft Position Sensor Circuit Low
	P0343	Camshaft Position Sensor Circuit High
Idle switch	P0510	Idle switch - Closed Throttle Position Switch
Battery Voltage	P0561	Battery voltage - System Voltage Unstable
	P0562	Battery Voltage - System Voltage Low
	P0563	Battery Voltage - System Voltage High
ETC position sensor	P0638	ETC control range - Throttle Actuator Control Range/Performance (Bank1)
	P1551	ETC cause of failure: limphome position
	P2100	ETC power stage - Throttle Actuator Control Motor Circuit/Open
	P2101	ETC position deviation - Throttle Actuator Control Motor Circuit Range/Performance
	P2107	ETC cause of failure: amplifier adjustment - Throttle Actuator Control Module Processor
	P2119	ETC cause of failure spring check - Throttle Actuator Control Throttle Body Range/Performance
	P2176	ETC cause of failure - Throttle Actuator Control System – Idle Position Not Learned
Pedal poistion sensor	P2122	APS1 - Pedal Position Sensor Circuit Low Input
	P2123	APS1 - Pedal Position Sensor Circuit High Input
	P2127	APS2 - Pedal Position Sensor Circuit Low Input
	P2128	APS2 - Pedal Position Sensor Circuit High Input
	P2138	APS - Pedal Position Sensor Voltage Correlation - Pedal movinG detection
Control Module	U0073	Control Module Bus Off
Speed mode monitoring	P1297	Vehicle Overspeed Condition
	P0501	Vehicle Speed Sensor Range / Performance

2. Measurment

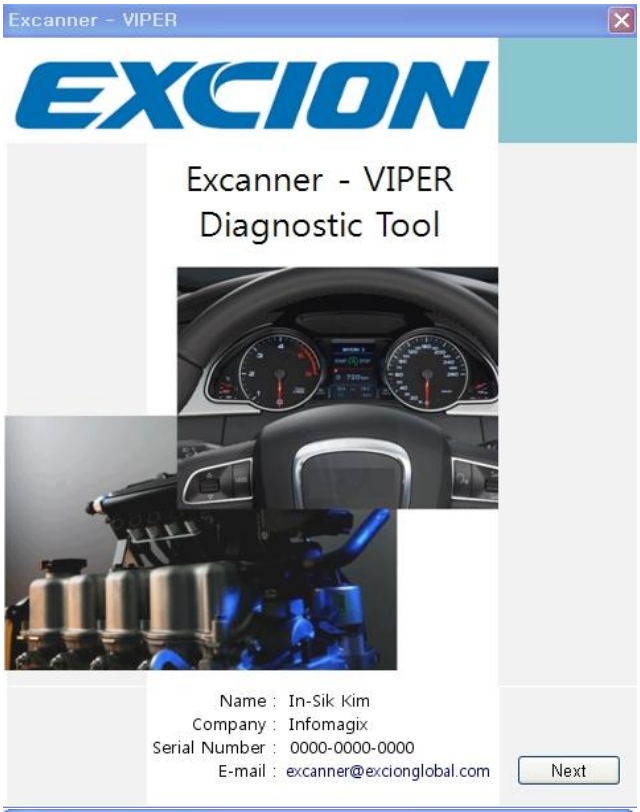
2.1 Diagnosis; Signal intake air temperature sensor

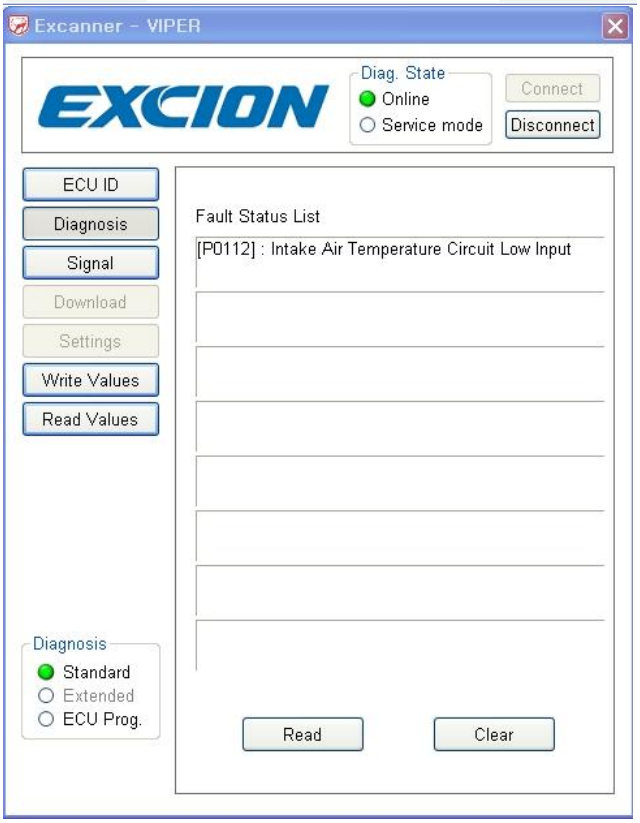
Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Intake Air Temperature (IAT) Sensor Circuit Low	P0112	Range check - low	Measured air temperature > 133.5		Set the default value (20'C) for intake air temperature	Immediately	Immediately
Intake Air Temperature (IAT) Sensor Circuit High	P0113	Range check - high	Measured air temperature < -30	time after start finished > 240 sec engine idle No fuel cut-off		Immediately	Immediately

[Picture2]: SCAN Tool_P0113_Intake Air Temperature Circuit High



[Picture3]: SCAN Tool_P0112_Intake Air Temperature Circuit Low


Excanner - VIPER
EXCION
Excanner - VIPER
Diagnostic Tool
Name : In-Sik Kim
Company : Infomagix
Serial Number : 0000-0000-0000
E-mail : excanner@excionglobal.com
Next

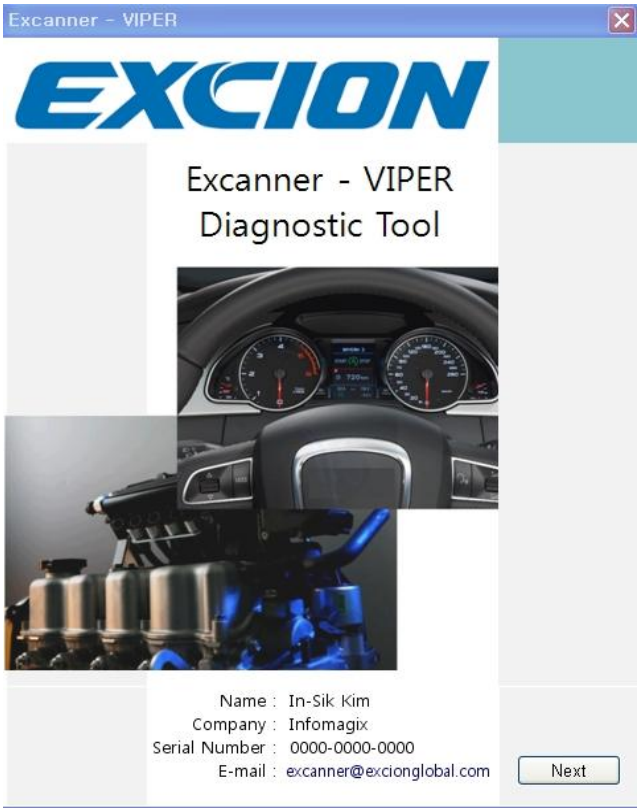

Excanner - VIPER
EXCION
Diag. State
Online
Service mode
Connect
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0112] : Intake Air Temperature Circuit Low Input
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

2.2 Diagnosis; Evaluation of signal engine temperature sensor

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Engine Coolant Temperature (ECT) Sensor Circuit Low	P0117	Signal check low	Sensored temperature > 128.3'C	-	Set the model-based substitute value of engine temperature(tmew)	Immediately	Immediately
Engine Coolant Temperature (ECT) Sensor Circuit High	P0118	Signal check high	Sensored temperature < -38.3'C	-		Immediately	Immediately

[Picture4]: SCAN TOOL_P0117_Evaluation of signal engine temperature sensor Circuit Low

[Picture5]: SCAN TOOL_P0118_Evaluation of signal engine temperature sensor Circuit High


Excanner - VIPER
EXCION
Excanner - VIPER
Diagnostic Tool
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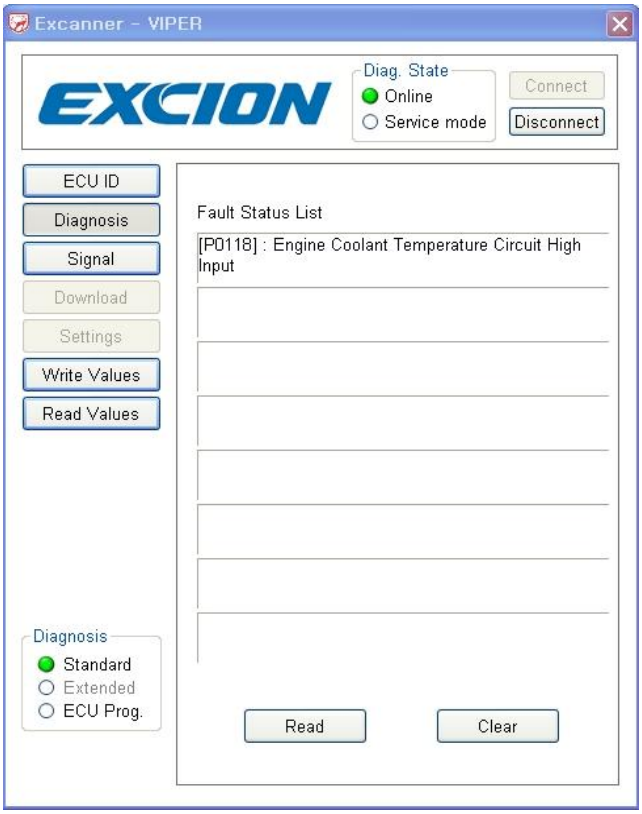
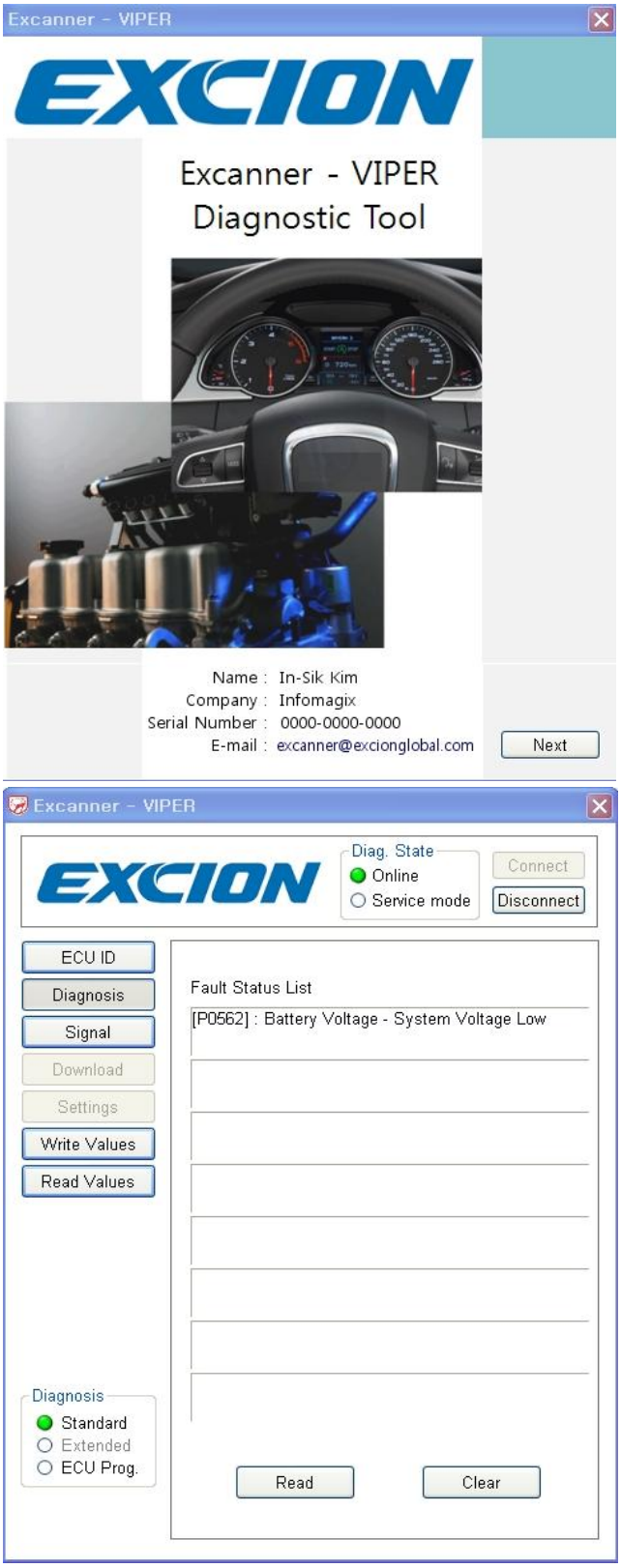
Company : Infomagix
Serial Number : 0000-0000-0000
E-mail : excanner@excionglobal.com
Next


Excanner - VIPER
EXCION
Diag. State
Online
Service mode
Connect
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0118] : Engine Coolant Temperature Circuit High Input
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

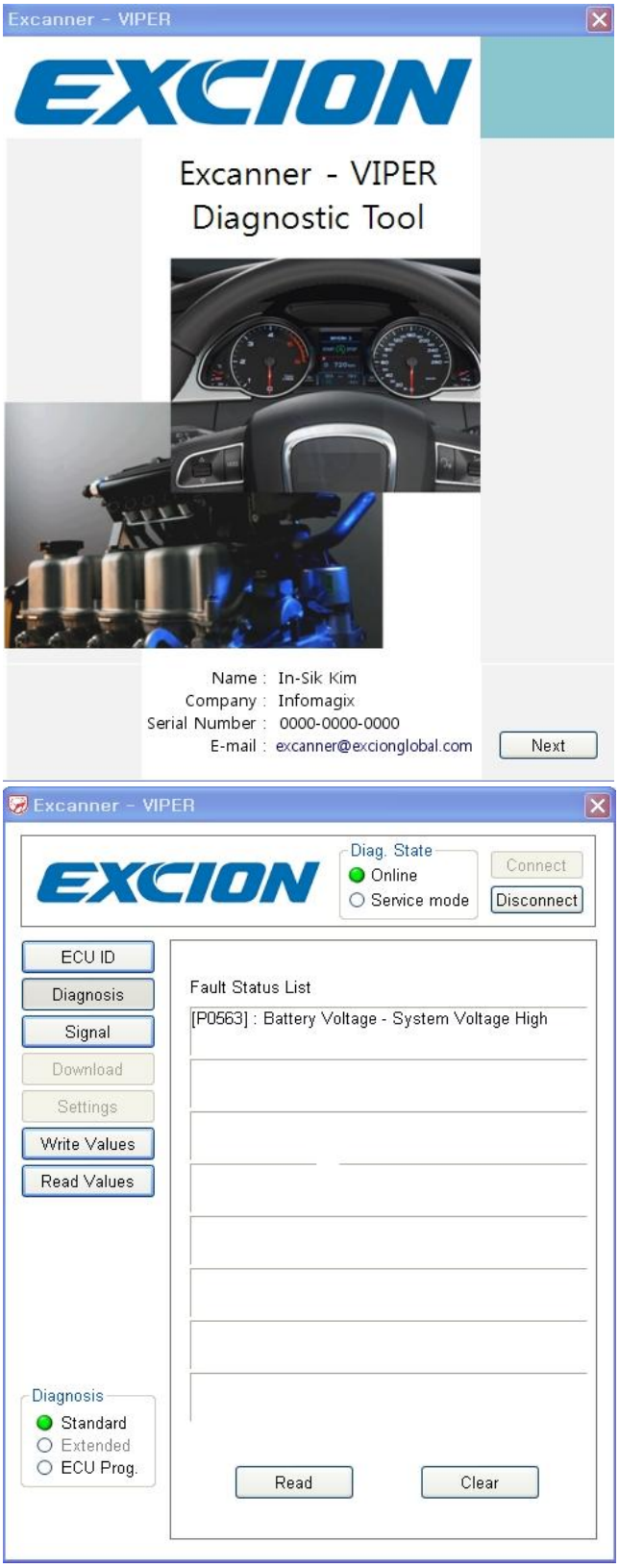
2.3 Diagnosis; Sensor variable for battery voltage incl. diagnosis

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
System Voltage Low	P0562	Signal check low	system voltage : 2.48 ~ 10.01V	time after engine start > 120 sec	Set the model-based substitute value of engine temperature(tmew)	Immediately	Immediately
System Voltage High	P0563	Signal check high	System voltage > 16.98V	time after engine start > 120 sec Vehicle speed > 25kph		Immediately	Immediately
System Voltage Unstable	P0561	Signal check					

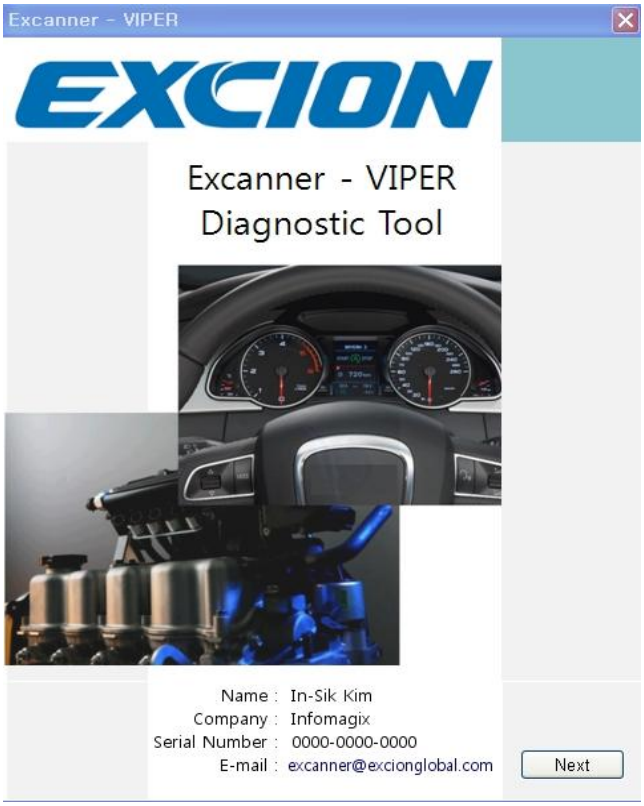
[Picture6]: SCAN TOOL_Sensor variable for battery voltage low



[Picture7]: SCAN TOOL_Sensor variable for battery voltage High



[Picture8]: SCAN TOOL_Sensor variable for battery voltage Unstable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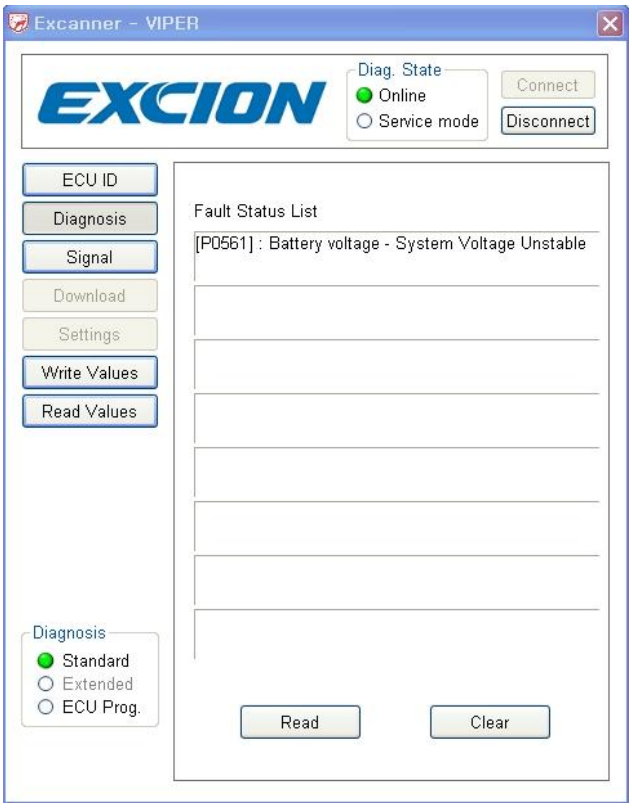
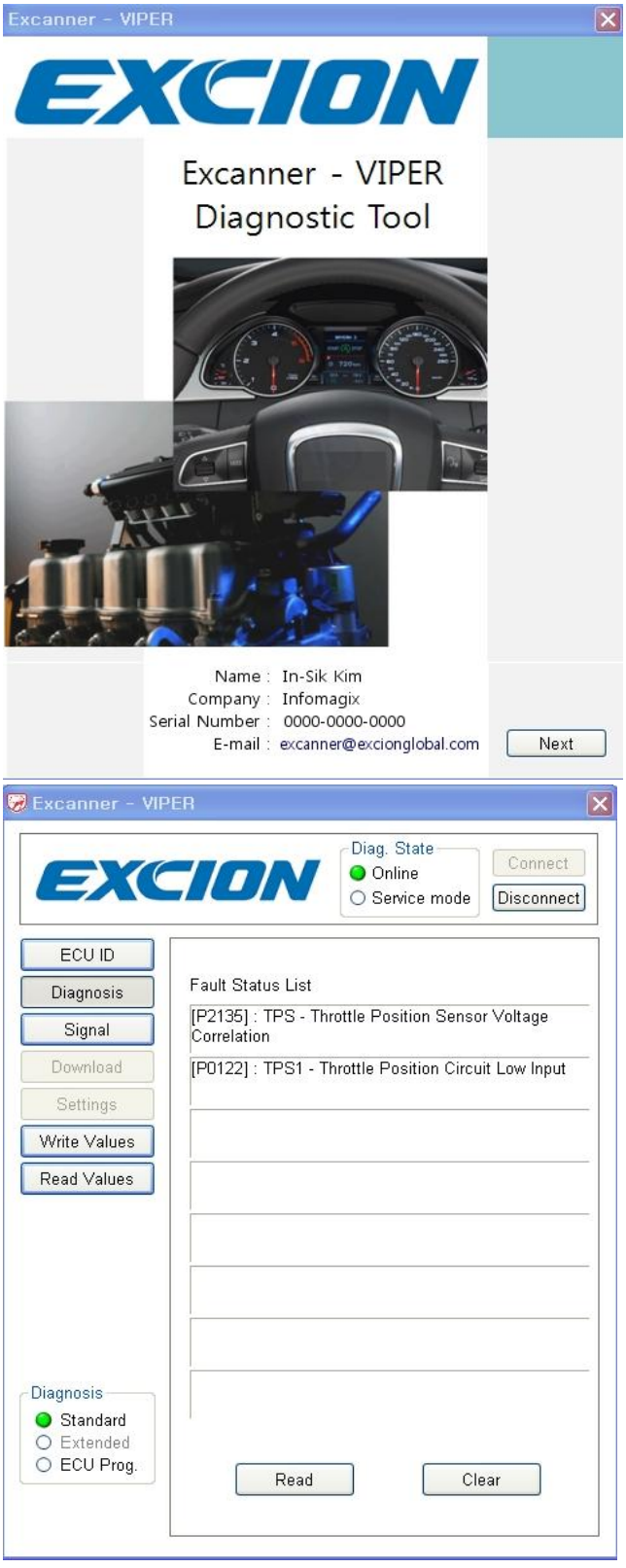
EXCION
Excanner - VIPER
Diagnostic Tool
Name : In-Sik Kim
Company : Infomagix
Serial Number : 0000-0000-0000
E-mail : excanner@excionglobal.com
Next


Excanner - VIPER
EXCION
Diag. State
Online
Service mode
Connect
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0561] : Battery voltage - System Voltage Unstable
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

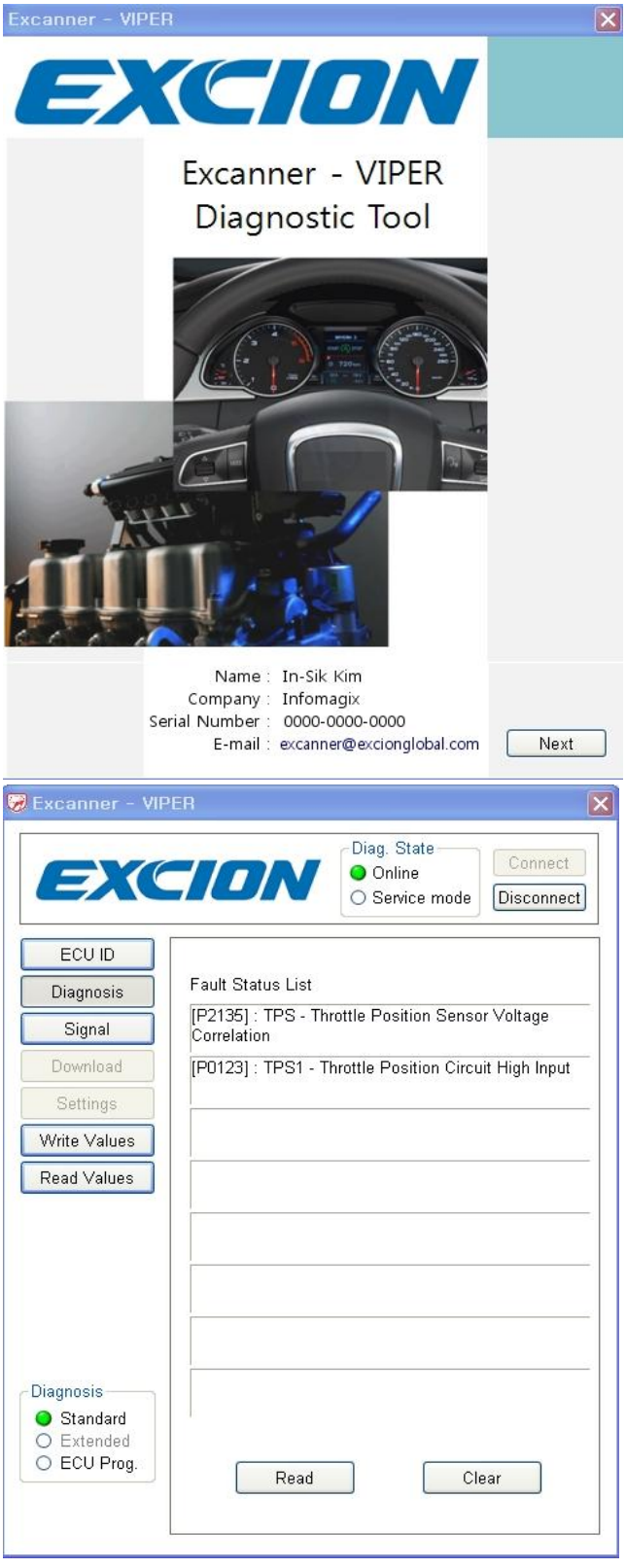
2.4 Diagnosis: ETS Actuator DV-E

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
throttle position sensor Voltage Correlation	P2135	Fault from DK1 and DK2	-	-	-Use another sensor signal sensor1 fault --> use sensor 2 sensor2 fault --> use sensor 1	Immediately	Short Driving
Throttle Position (TP) Sensor 1 Circuit Low	P0122	Short cirucit to ground, Open circuit	Sensor voltage < 0.176V	IG on		Immediately	Short Driving
Throttle Position (TP) Sensor 1 Circuit High	P0123	Short circuit to Battery voltage	Sensor voltage > 4.8V	IG on		Immediately	Short Driving
Throttle Position (TP) Sensor 2 Circuit Low Voltage	P0222	Range check - low	Sensor voltage < 0.1V	Engine speed > 1200 rpm		Immediately	Short Driving
Throttle Position (TP) Sensor 2 Circuit High Voltage	P0223	Range check - high	Sensor voltage > 4.98V	IG on		Immediately	Short Driving

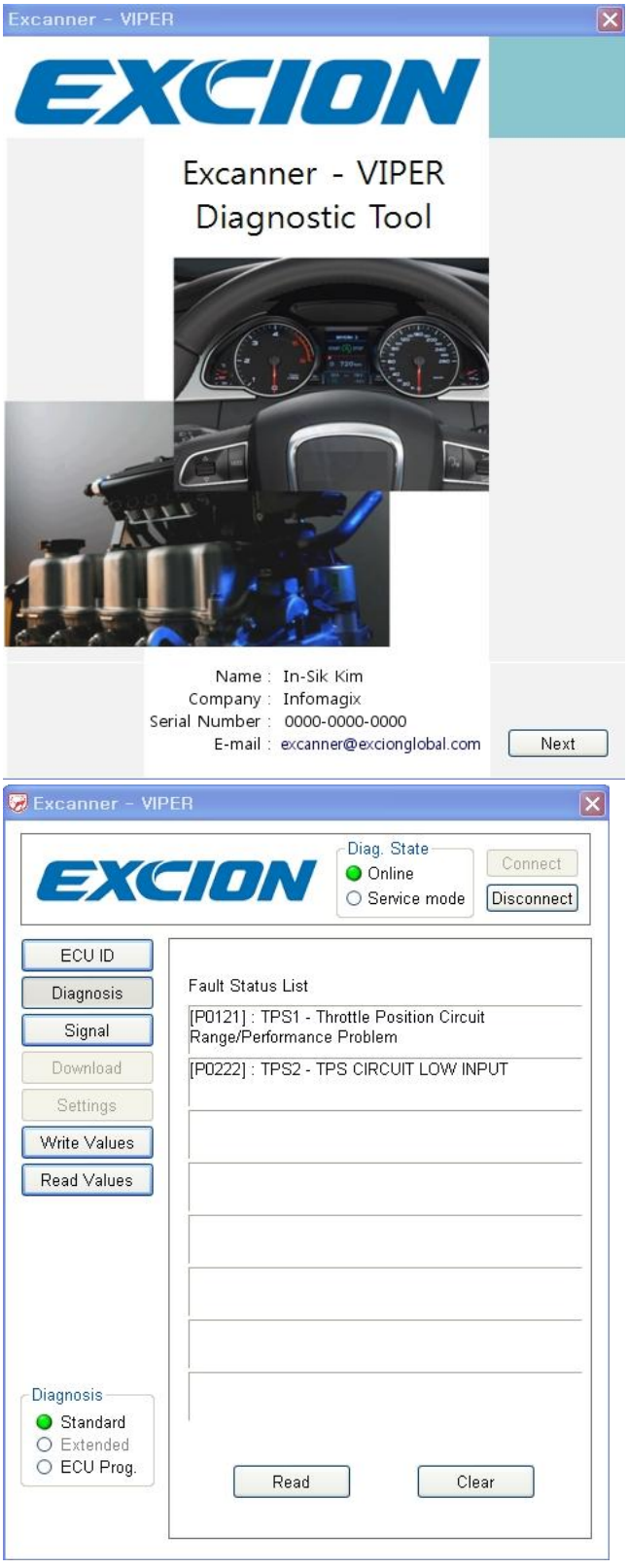
[Picture9]: P2135&P0122_Throttle Position (TP) Sensor 1 Circuit Low & Voltage Correlation



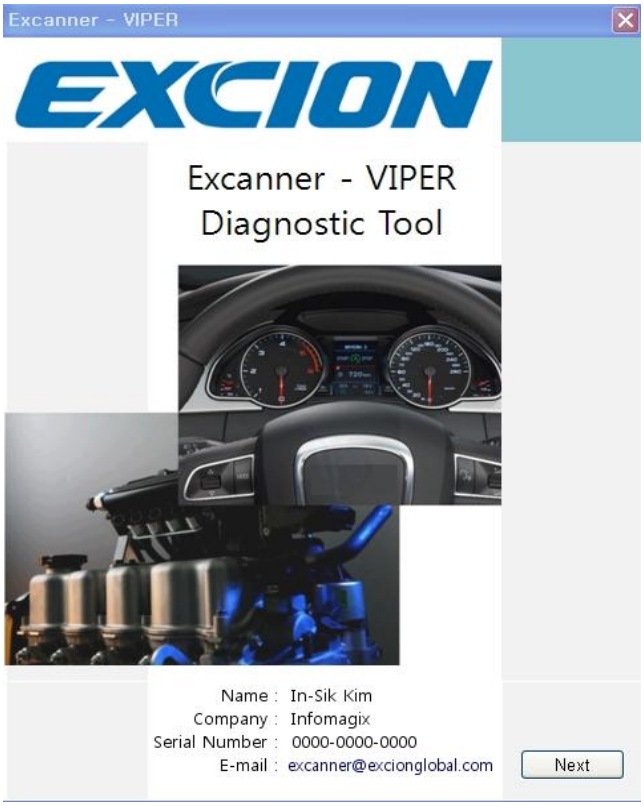
[Picture10]: P2135&P0123_Throttle Position (TP) Sensor 1 Circuit High & Voltage Correlation



Picture11]: Throttle Position (TP) Sensor 2 Circuit Low & Voltage Correlation



Picture12]: P2135&P0223_Throttle Position (TP) Sensor 2 Circuit High & Voltage Correlation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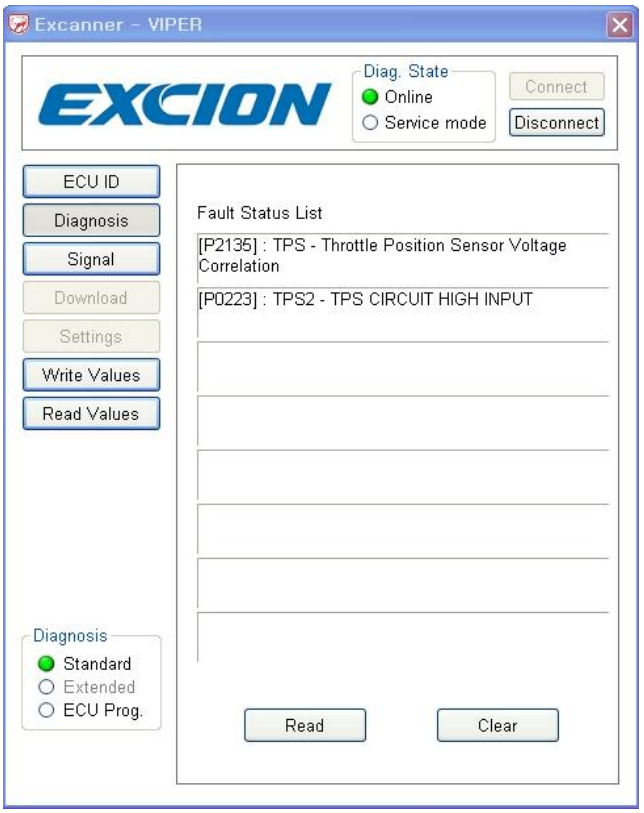
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ECU ID
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Signal
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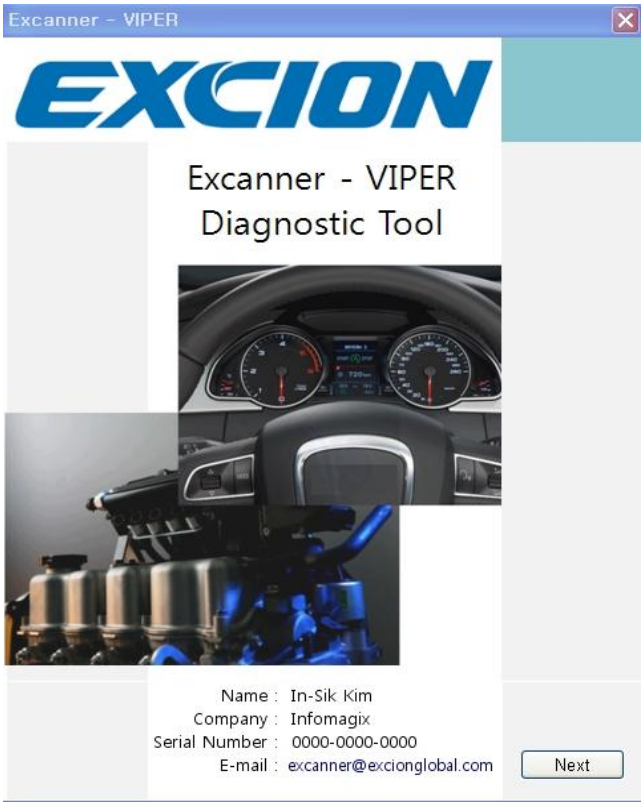
Settings
Write Values
Read Values
Fault Status List
[P2135] : TPS - Throttle Position Sensor Voltage Correlation
[P0223] : TPS2 - TPS CIRCUIT HIGH INPUT
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

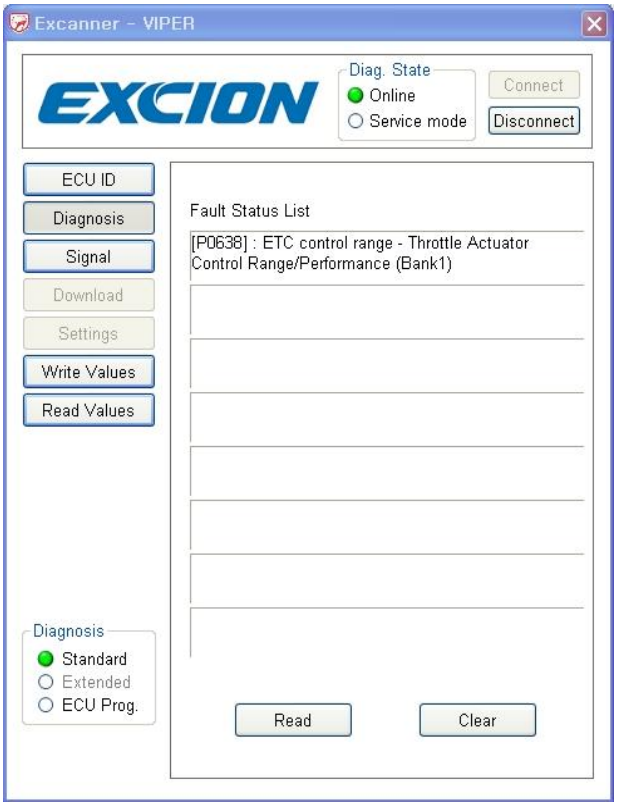
2.5 Diagnosis: ETS Actuator

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
ETC control range - Throttle Actuator Control Range/Performance	P0638	Drive line short cut, open throttle plate stick, stiff	DLR for DV-E: Sum of the PID-components > 80% Fault counter DLR setting range monitoring > 0.5%	IG on	torque limitation - limitation of acceleration pedal value for controller	Immediately	Immediately
ETC cause of failure: limphome position	P1551	NLP position error	Throttle angle in the limphome air position < 1.8% or > 13.0785%	under DVE initialization		Immediately	Immediately
ETC power stage - Throttle Actuator Control Motor Circuit/Open	P2100	IC internal error	custom driver specification			Immediately	Immediately
ETC position deviation - Throttle Actuator Control Motor Circuit Range/Performance	P2101	Drive line short cut, open throttle plate stick, stiff	|Predicted throttle angle - actual throttle angle| > map(4 ~ 50 %) Fault counter throttle position monitoirng > 0.5 %	IG on		Immediately	Immediately
ETC cause of failure: amplifier adjustment - Throttle Actuator Control Module Processor	P2107	Amplifier failure	Real amplified DK-poti-1-value at the upper adjustment point < 10V Real DK-poti-1-value at the lower adjustment point >(5 V) voltage offset of DK < -0.055V potentiometer 1 amplification charcteristic > 0.055V amplification of throttle	under DVE initialization		Immediately	Immediately

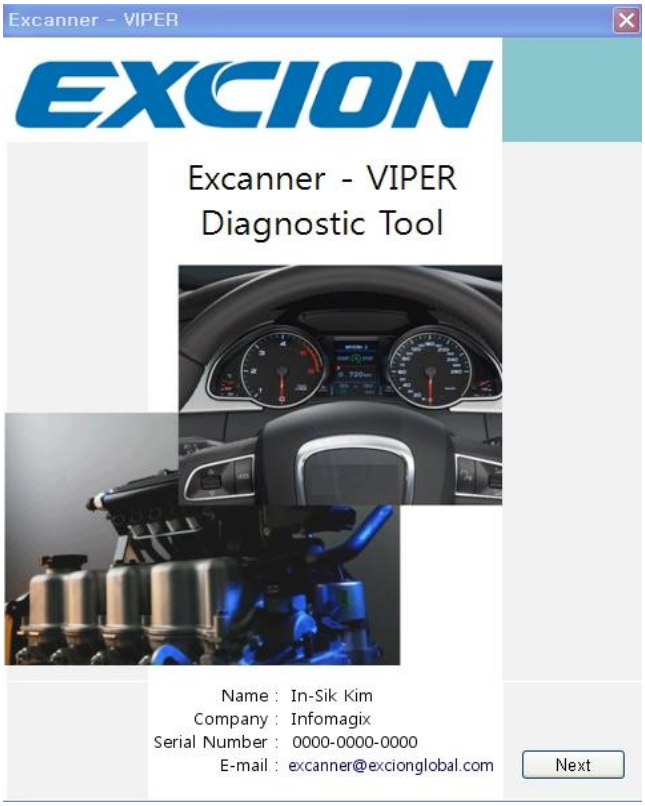
			potentiometer 1 > 4.3242V or < 3.9961v				
ETC cause of failure spring check - Throttle Actuator Control Throttle Body Range/Performance	P2119	Return spring failure (canot be closed)	Throttle angle - throttle angle in the limphome air position > 2.9999 % time counter throttle return spring check > 0.560 s	IG on		Immediately	Immediately
ETC cause of failure - Throttle Actuator Control System – Idle Position Not Learned	P2176	UMA learning error : Lower mechanical stop position error (No adaptation value is written in flash ROM.)	Voltage DK-poti 1 at the lower limit stop, steady-state part < 0.212 V or (0.865 + 0.02560 V voltage DK-poti 2 at the lower limit stop, steady-state part >4.84 V or < (4.14 + 0.0256)V sensor voltage from throttle potentiometer 1 - Voltage DK-poti 1 at the lower limit stop, steady-state part > 0.15V	ECU is new under DVE initialization		Immediately	Immediately

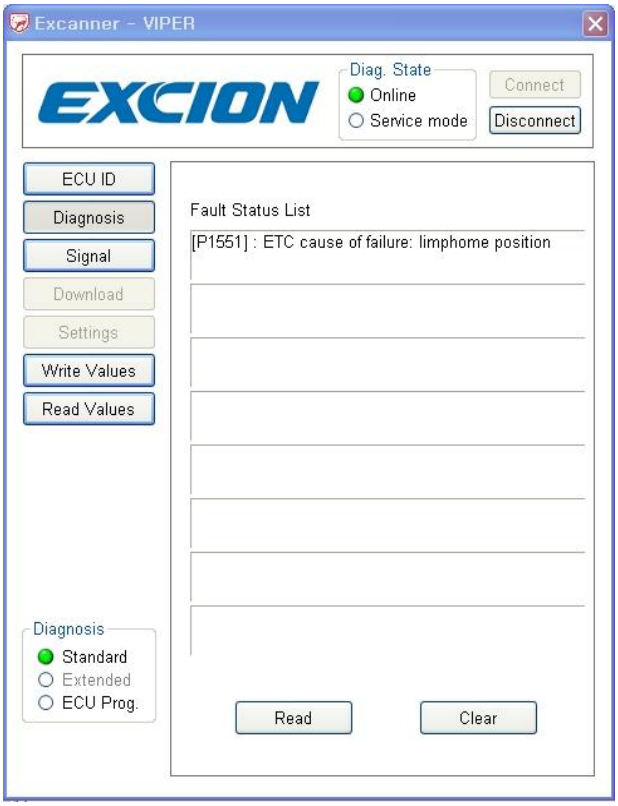
[Picture13]: SCAN TOOL_P0638_ ETS Actuator_ETC control range - Throttle Actuator Control Range/Performance



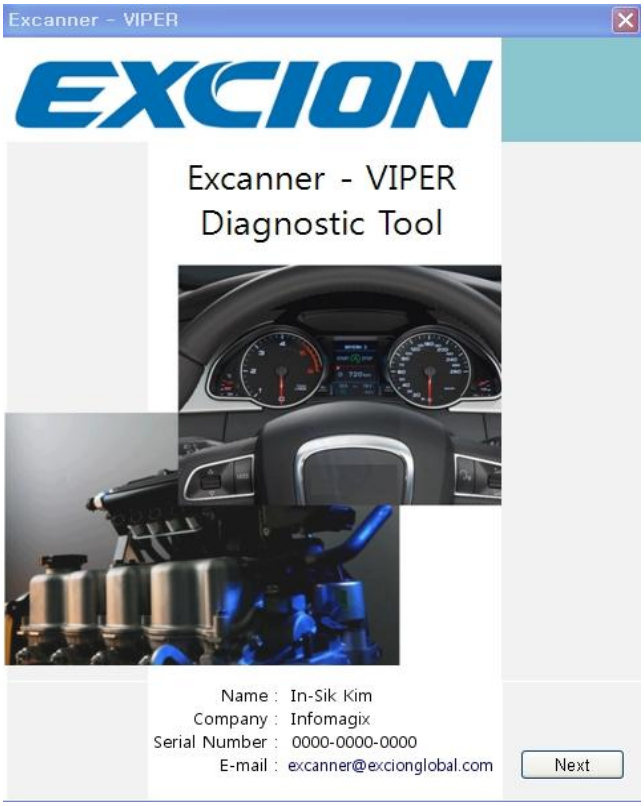


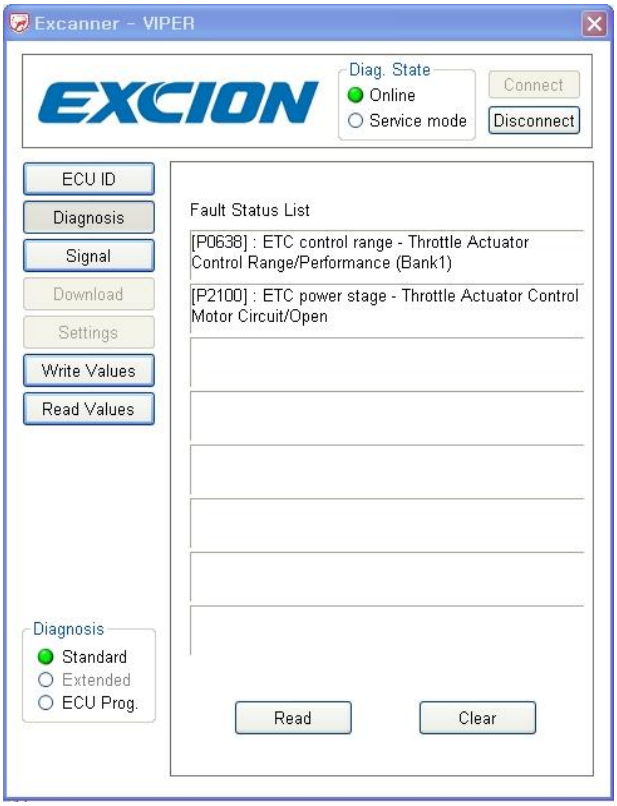
[Picture14]: SCAN TOOL_ P1551_ ETS Actuator_ETC cause of failure: limphome position



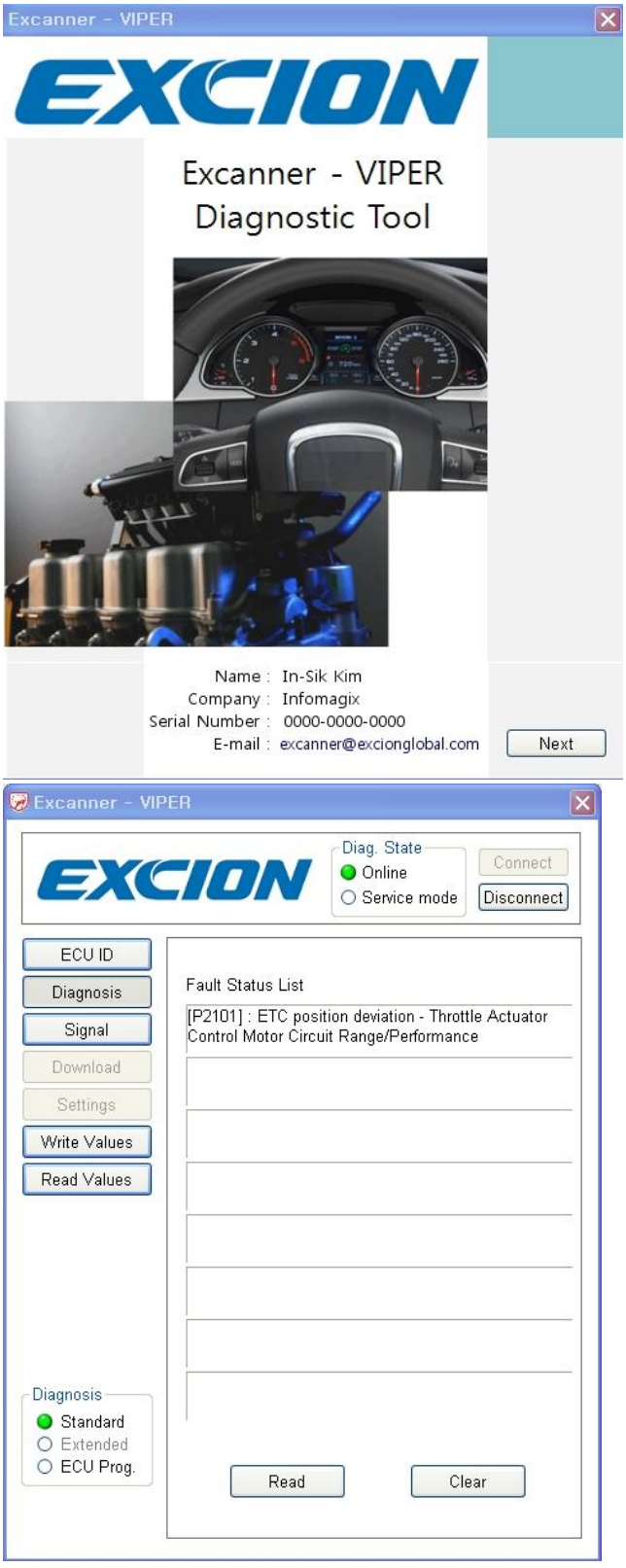


[Picture15]: SCAN TOOL_P2100_ETS Actuator_ ETC power stage - Throttle Actuator Control Motor Circuit/Open

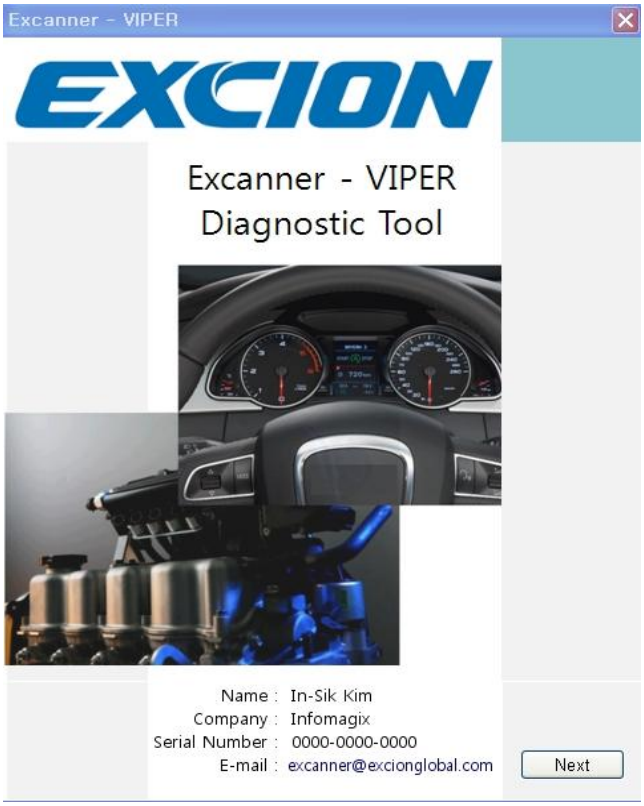


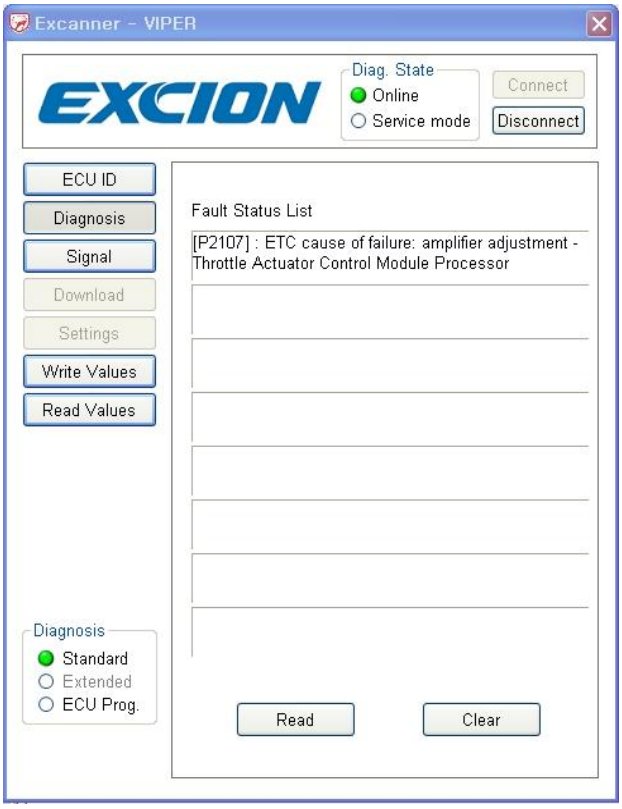


[Picture16]: SCAN TOOL_P2101_ETS Actuator_ETC position deviation - Throttle Actuator Control Motor Circuit Range/Performance

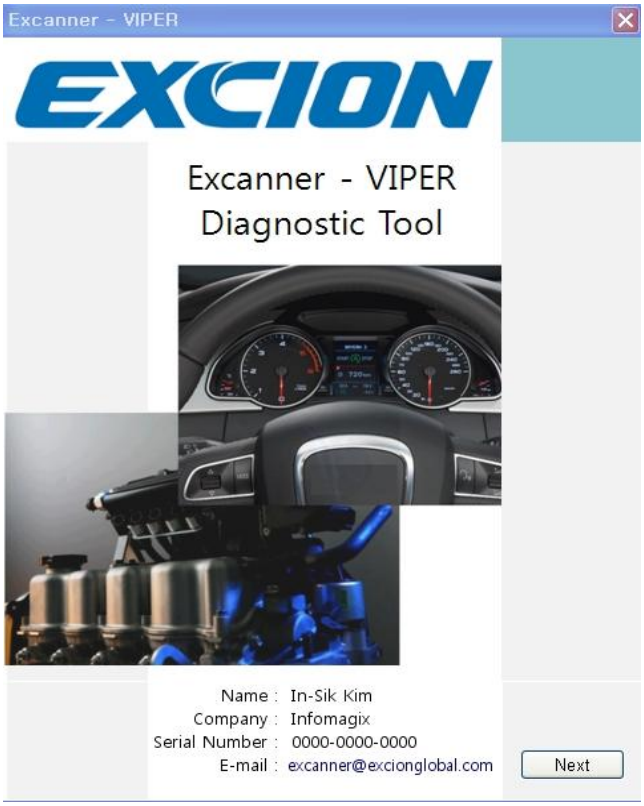


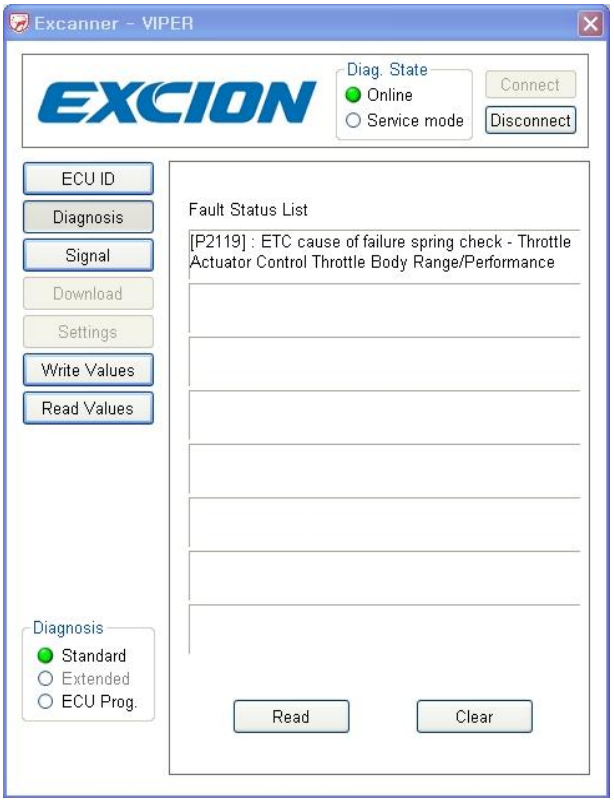
[Picture17]: SCAN TOOL_ P2107_ETS Actuator_ETC cause of failure: amplifier adjustment - Throttle Actuator Control Module Processor



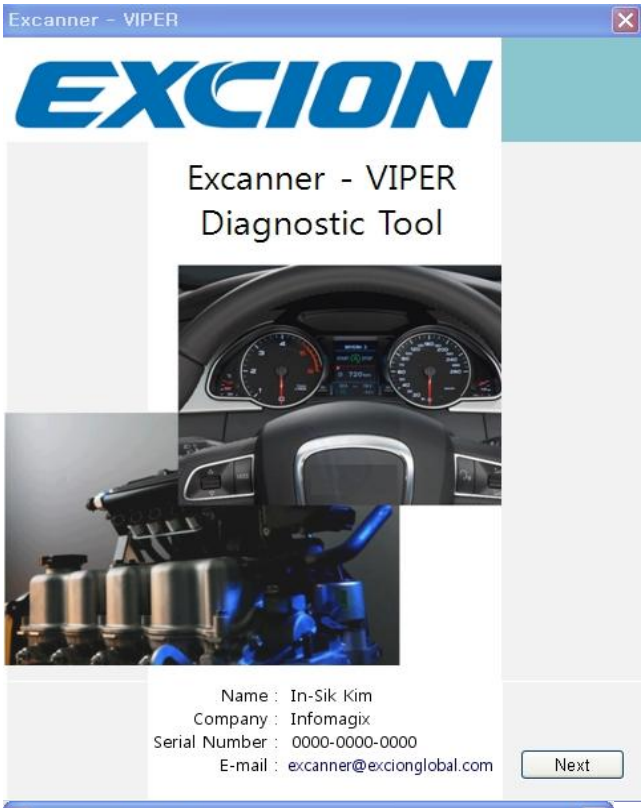


[Picture18]: SCAN TOOL_P2119_ETC cause of failure spring check - Throttle Actuator Control Throttle Body Range/Performance





[Picture19]: SCAN TOOL_P2176_ETS Actuator_ETC cause of failure - Throttle Actuator Control System – Idle Position Not Learned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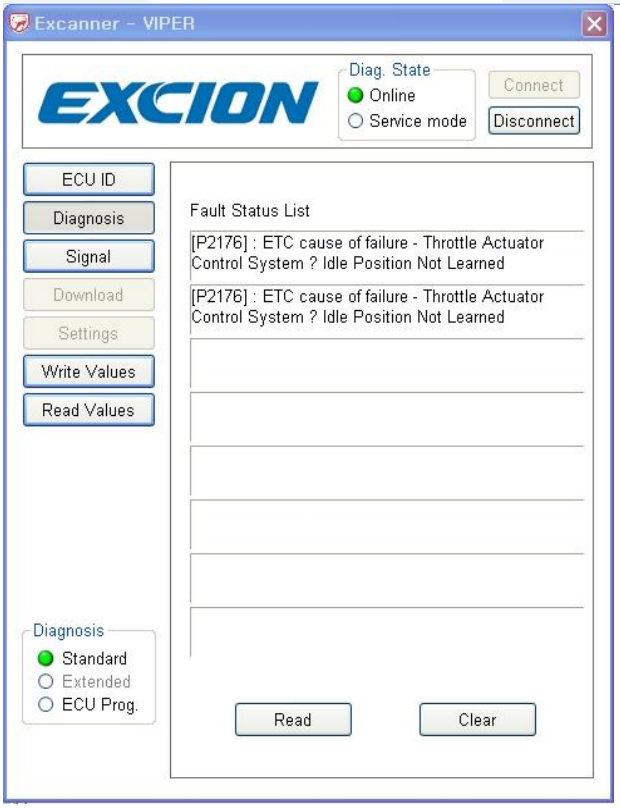
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Disconnect
ECU ID
Diagnosis
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Settings
Write Values
Read Values
Fault Status List
[P2176] : ETC cause of failure - Throttle Actuator Control System ? Idle Position Not Learned
[P2176] : ETC cause of failure - Throttle Actuator Control System ? Idle Position Not Learned
Diagnosis
Standard
Extended
ECU Prog.
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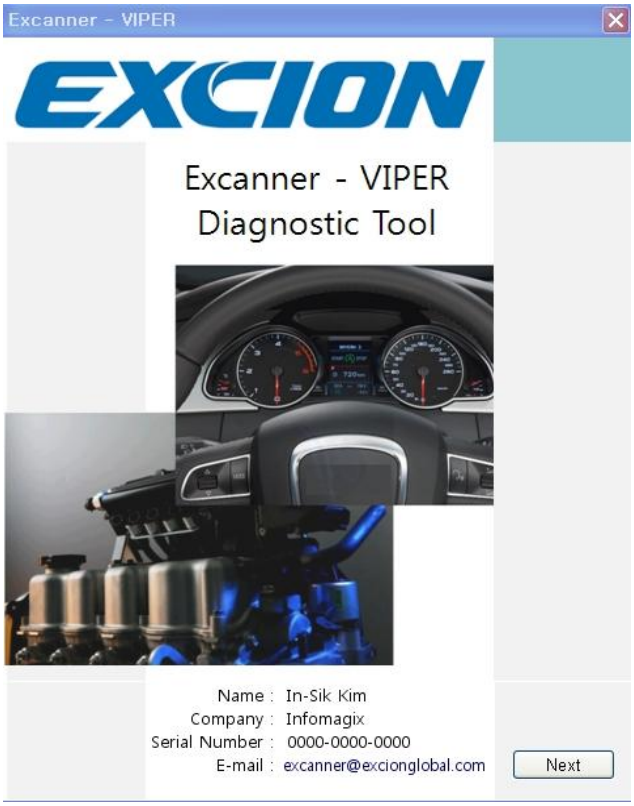
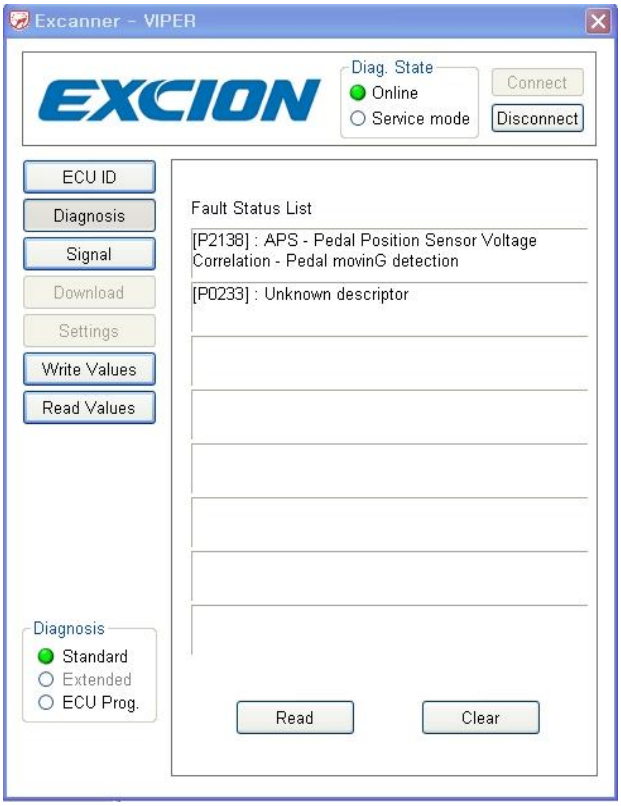
Clear

2.6 Diagnosis; Acceleration Pedal Position

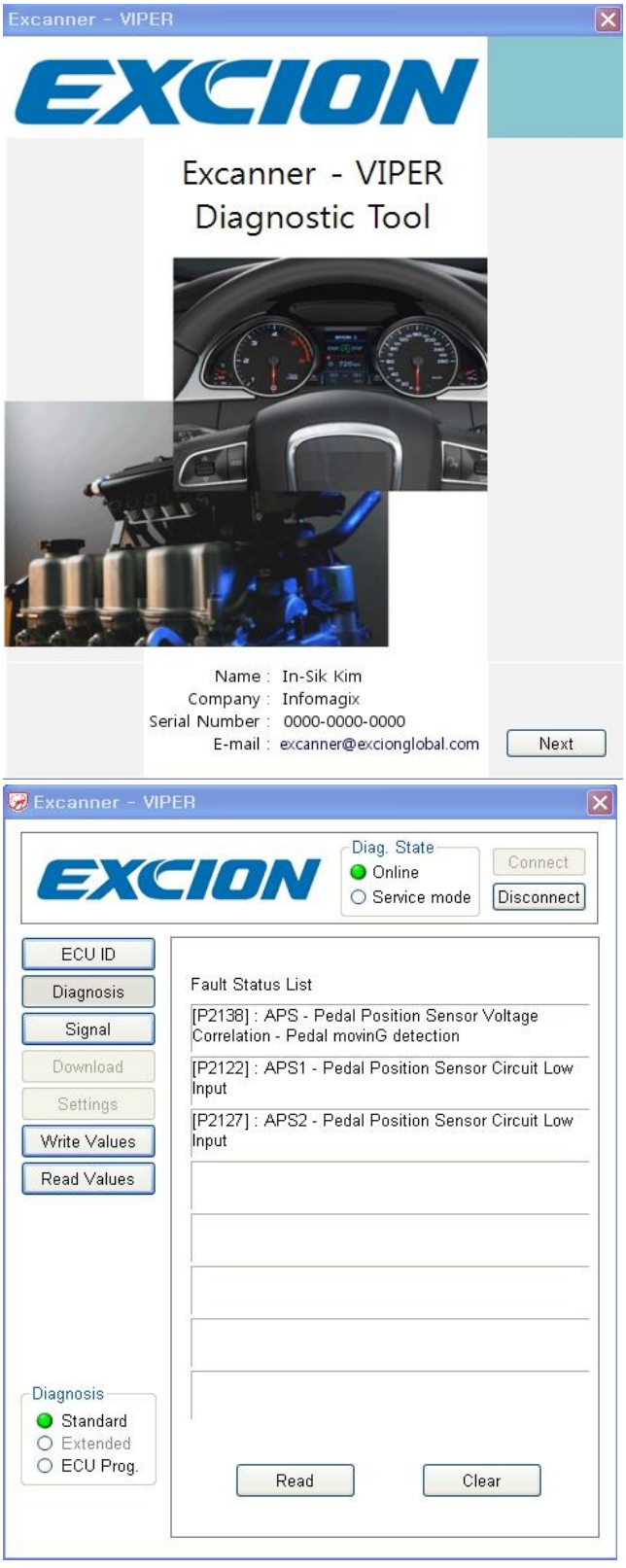
Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Acceleration Pedal Position(APP): Position sensor moving detection	P2138	signal check	Any sensor error from APP sensor 1 and 2	-	-	Immediately	Immediately
Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage	P2122	Short circuit to Ground, Open circuit	sensor voltage < 0.2V	Battery voltage>8V		Immediately	Immediately
Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage	P2123	Short circuit to Battery voltage	sensor voltage > 4.53V	IG on		Immediately	Immediately
Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage	P2127	Short circuit to Ground, Open circuit	Sensor voltage < 0.2V	IG on		Immediately	Immediately
Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage	P2128	Short circuit to Battery voltage	Sensor voltage > 4.53V	Battery voltage>8V		Immediately	Immediately

[Picture20]: SCAN TOOL_P2138_Acceleration Pedal Position(APP): Position sensor moving detection

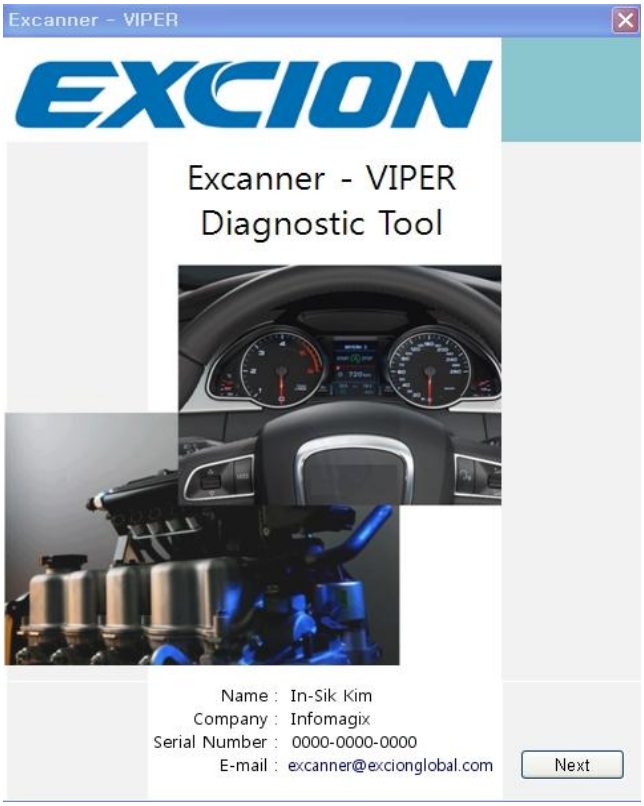




[Picture21]: SCAN TOOL_P2122&P2127_Sensor variable for accelerator pedal sensor 1&2 Low



[Picture22]: SCAN TOOL_P2123&P2128_Sensor variable for accelerator pedal sensor 1&2 High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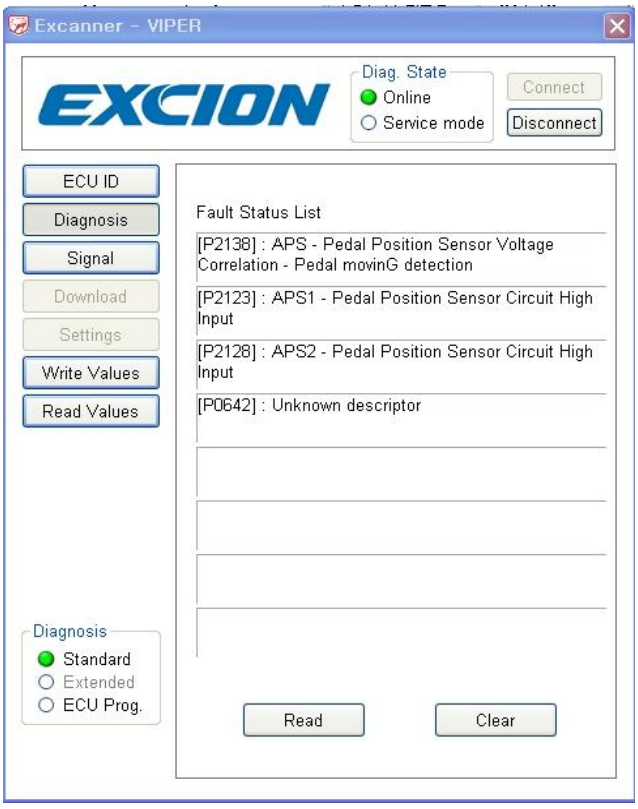
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Write Values
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Fault Status List
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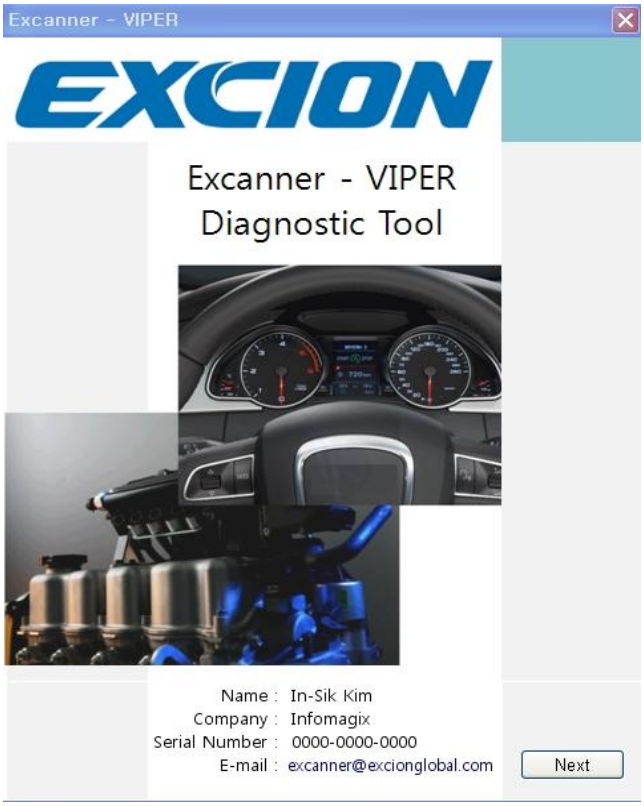
[P2123] : APS1 - Pedal Position Sensor Circuit High Input
[P2128] : APS2 - Pedal Position Sensor Circuit High Input
[P0642] : Unknown descriptor
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

2.7 Diagnosis; pressure sensor - intake manifold

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Manifold Absolute Pressure (MAP) Sensor Circuit	P0106	Manifold absolute pressure compared to the maximum and minimum threshold	MAP pressure reading > high, <low threshold based on engine speed and throttle angle	No ETC error time after start finished > 2 sec No MAP max error (P0108)	Intake manifold pressure is calculated based on modeled mass air flow map	Immediately	Immediately
Manifold Absolute Pressure (MAP) Sensor Circuit Low	P0107	compare sensor voltage	sensor voltage < 0.156 V	-		Immediately	Immediately
Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage	P0108	Short circuit to Battery voltage	sensor voltage > 4.961 V	-		Immediately	Immediately

[Picture23]: SCAN TOOL_P0107_Pressure sensor - intake manifold circuit low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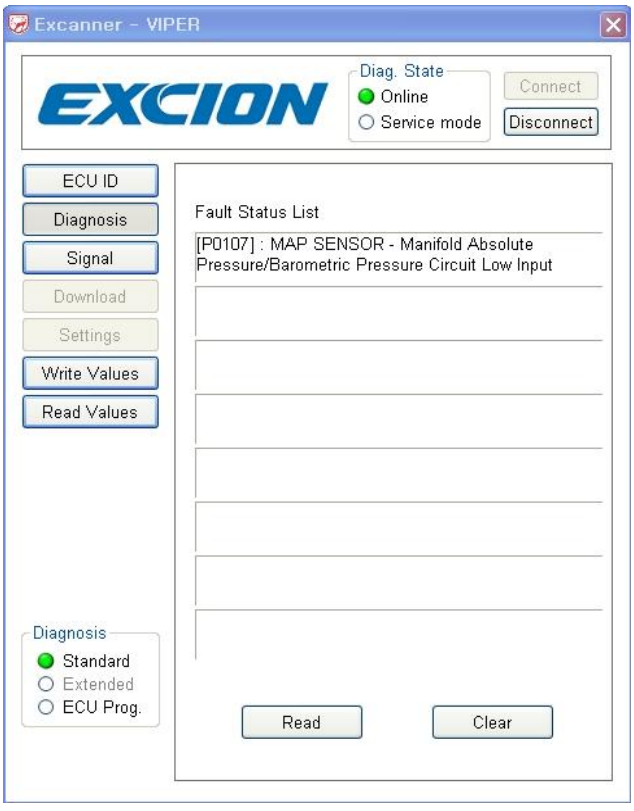
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Write Values
Read Values
Fault Status List
[P0107] : MAP SENSOR - Manifold Absolute Pressure/Barometric Pressure Circuit Low Input
Diagnosis
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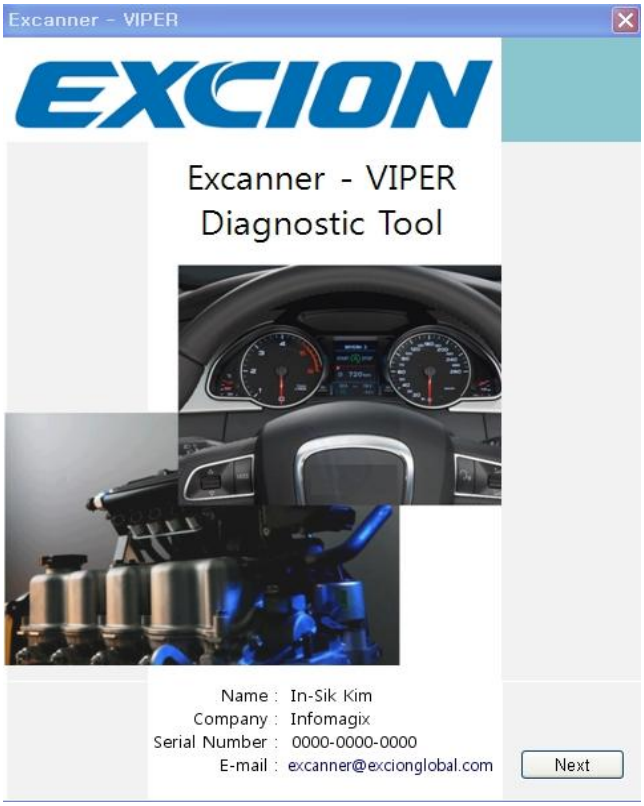
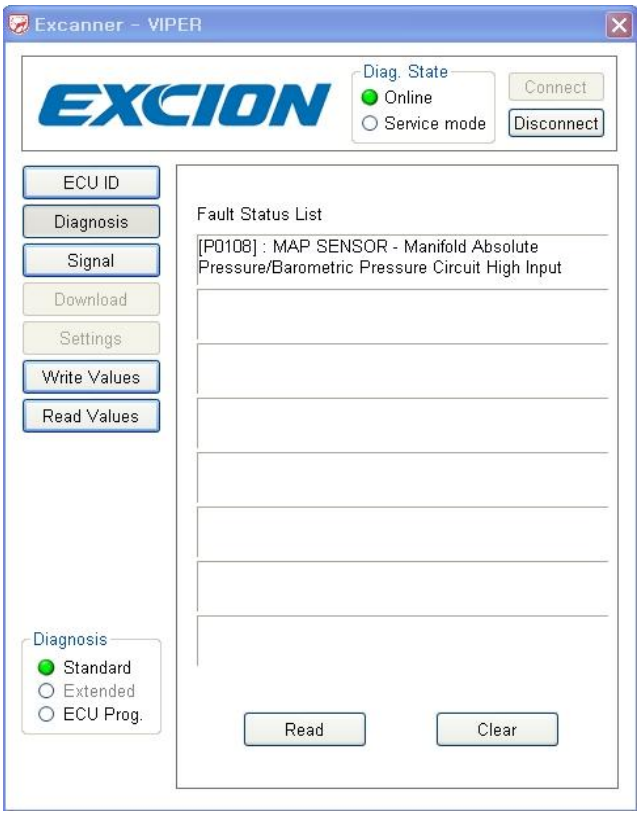
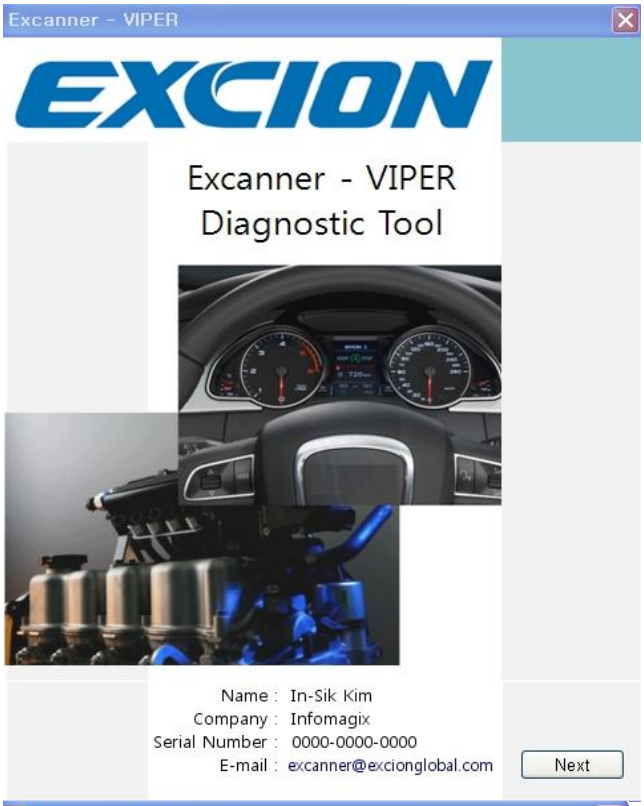
Extended
ECU Prog.
Read
Clear

[Picture24]: SCAN TOOL_P0108_Pressure sensor - intake manifold circuit High





[Picture25]: SCAN TOOL_P0106_Pressure sensor - intake manifold circuit perfomance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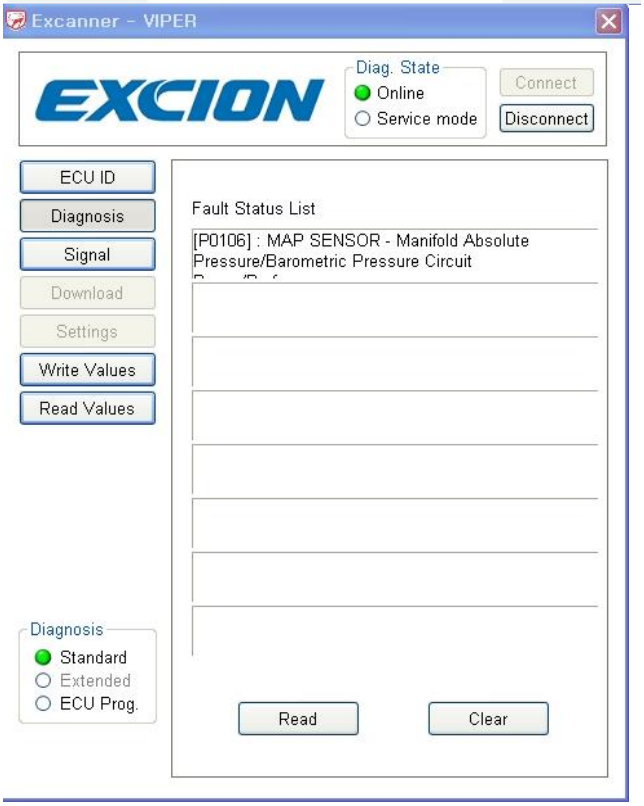
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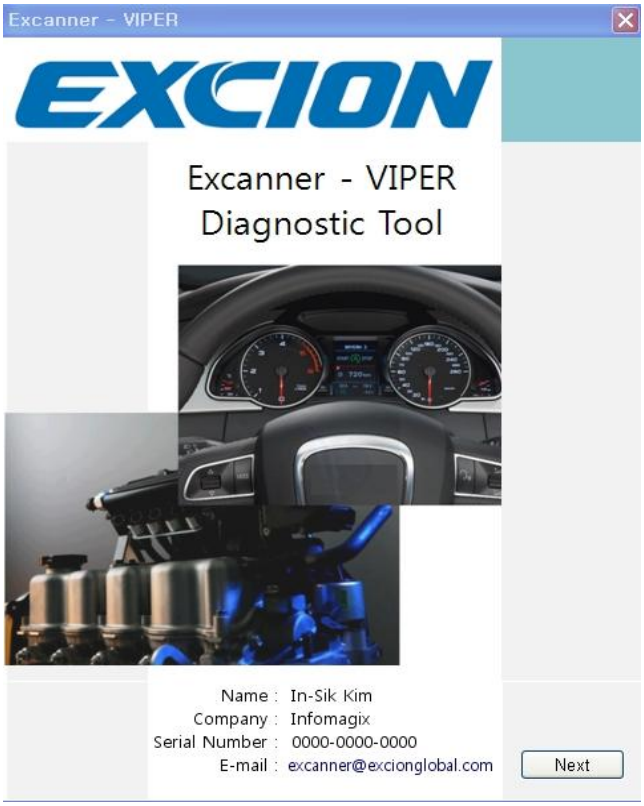
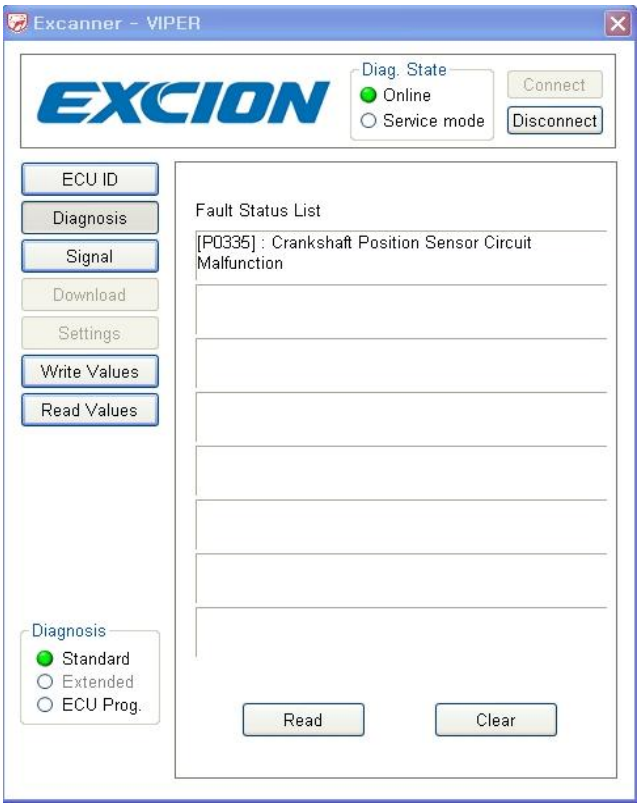
Write Values
Read Values
Fault Status List
[P0106] : MAP SENSOR - Manifold Absolute Pressure/Barometric Pressure Circuit
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

2.8 Diagnosis: engine speed sensor

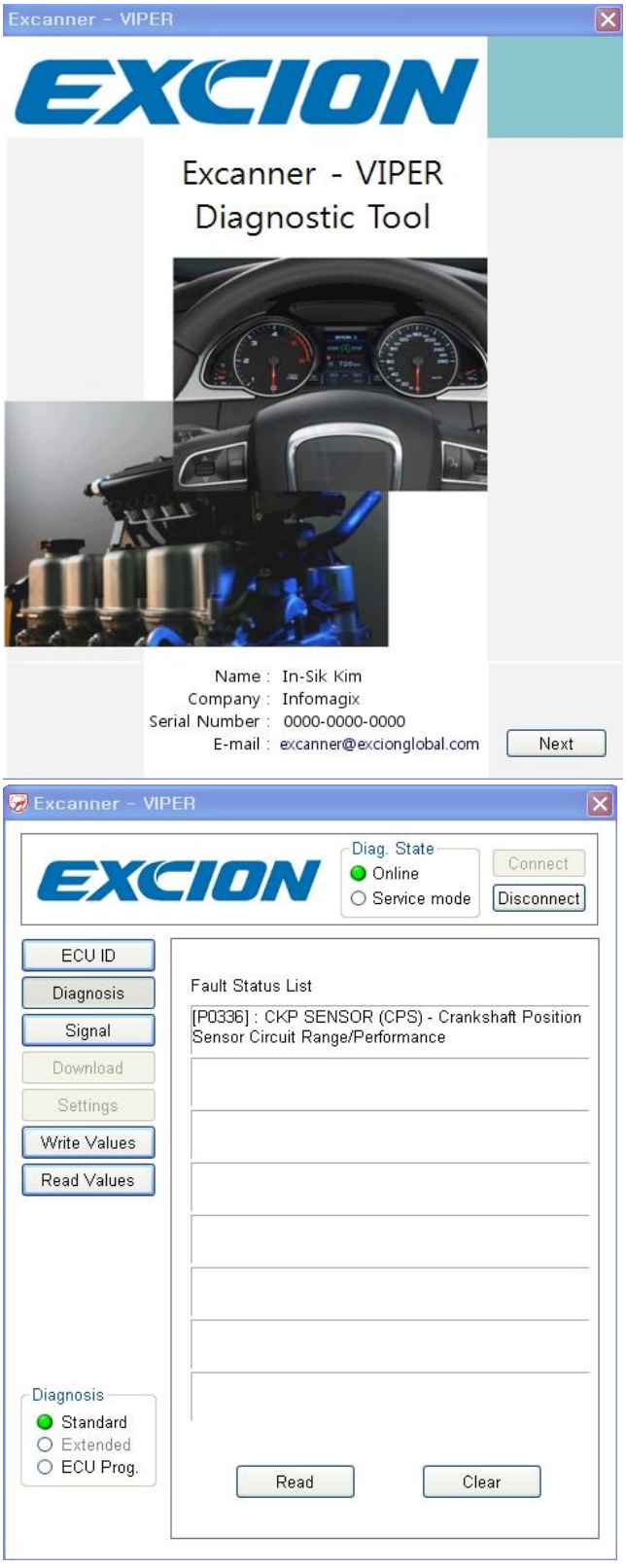
Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Crankshaft Position (CKP) Sensor A Circuit Malfunction	P0335	Signal check (short high/low, open circuit)	No signal	Edge counter of camshaft position sensor > 8	-	Immediately	Immediately
Crankshaft Position (CKP) Sensor A Performance	P0336	engine speed falling below minimum rpm, Reference mark frequently lost	engine speed fluctuation under 25 rpm is more than 10 times, Frequency counter of the lost reference gap > 1100 (11 times)	engine speed fluctuation check every 10 ms	-	Immediately	Immediately
Crankshaft Position (CKP) Sensor Circuit Low Duty Cycle	P0337	reference mark check tooth count is more/less between gap	Frequency counter of the gap correction (minus side) > 215	Idle speed > target speed - 50rpm	-	Immediately	Immediately
Crankshaft Position (CKP) Sensor Circuit High Duty Cycle	P0338		Frequency counter of the gap correction (plus side) > 215	vehicle speed <1kph or > 25kph	-	Immediately	Immediately

[Picture26]: SCAN TOOL_P0335_Engine speed sensor circuit

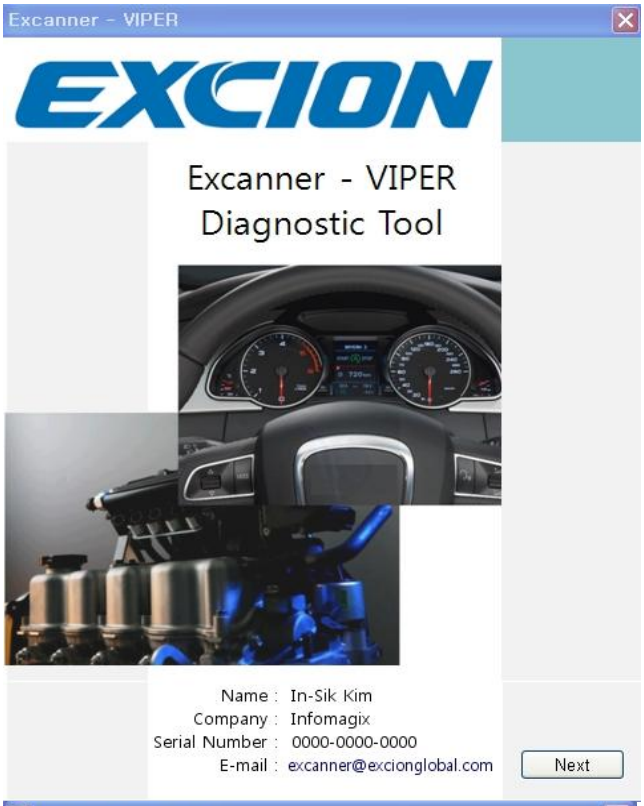




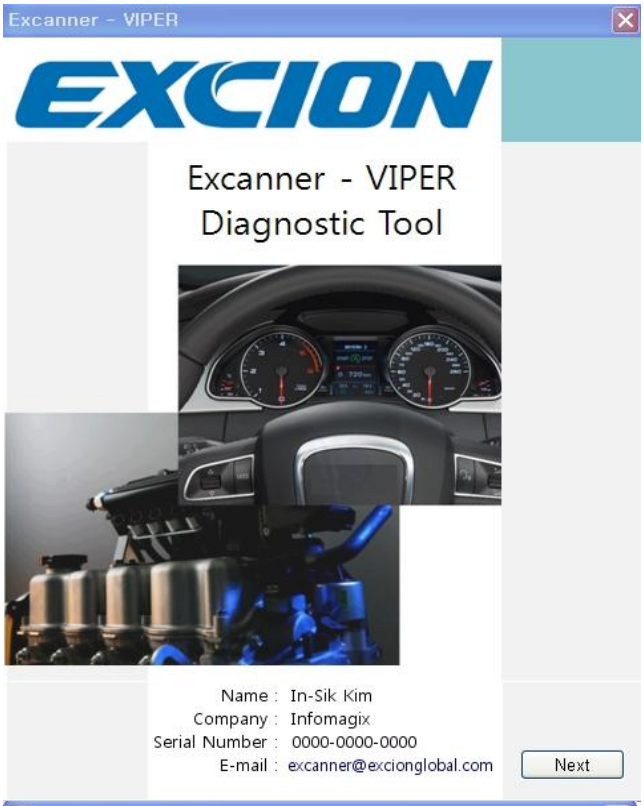
[Picture27]: SCAN TOOL_P0336_Engine speed sensor performance



[Picture28]: SCAN TOOL_P0335&P0337_Engine speed sensor circuit low



[Picture29]: SCAN TOOL_ P0335&P0338_Engine speed sensor circuit high & Malfunction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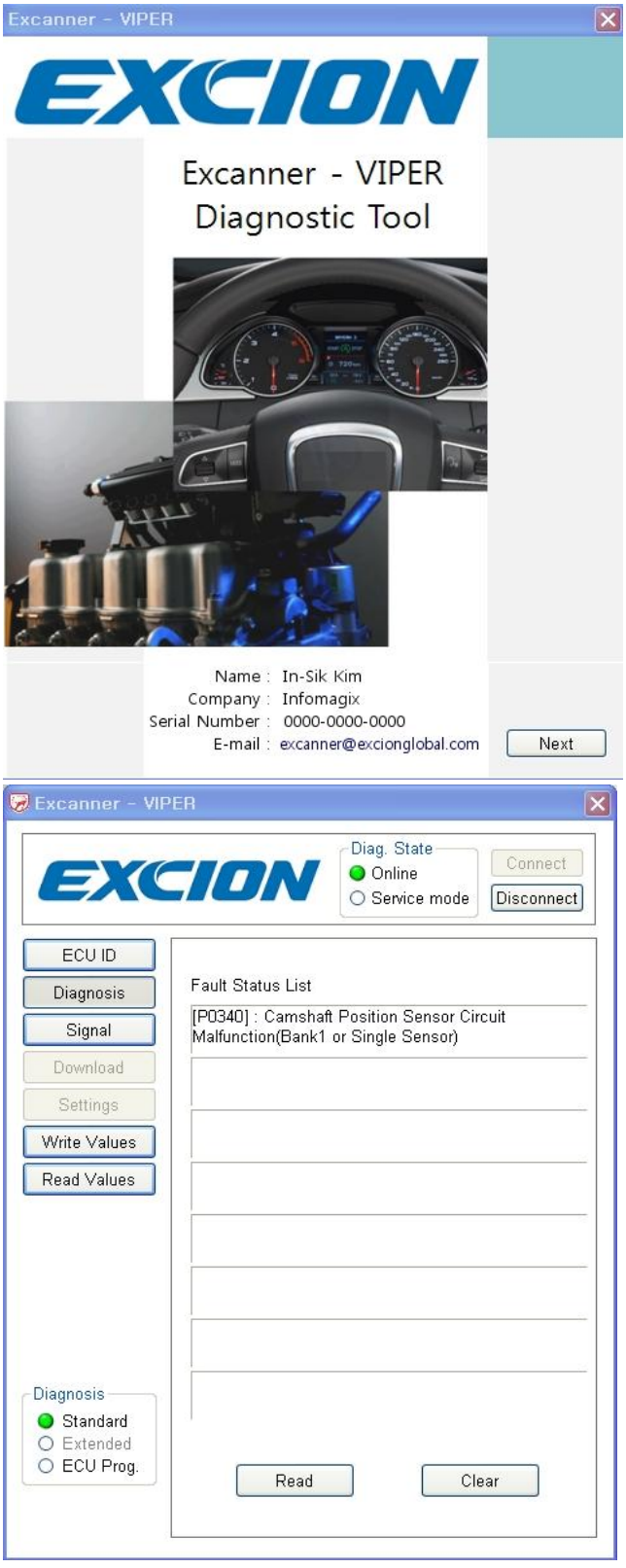
Read Values
Fault Status List
[P0338] : Crankshaft Position Sensor Circuit High
[P0335] : Crankshaft Position Sensor Circuit Malfunction
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

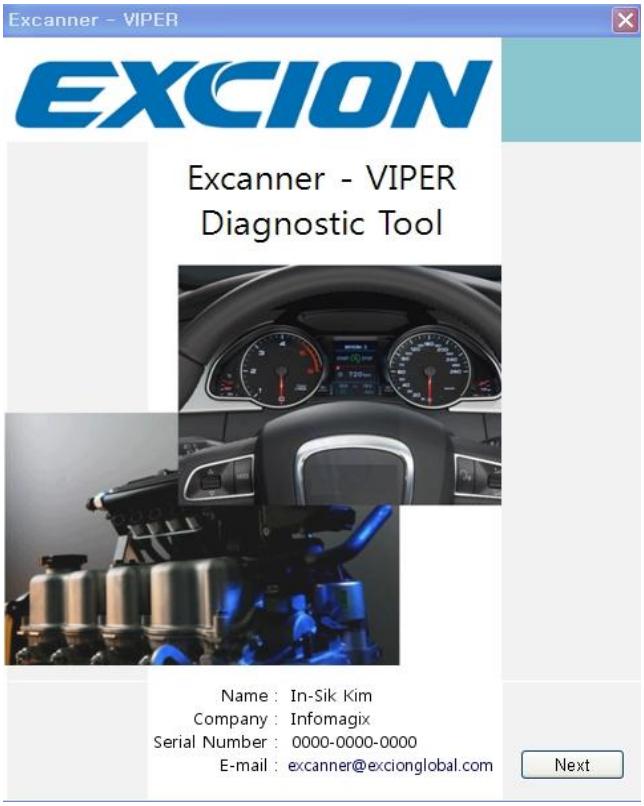
2.9 Diagnosis; plausibility test phase sensor

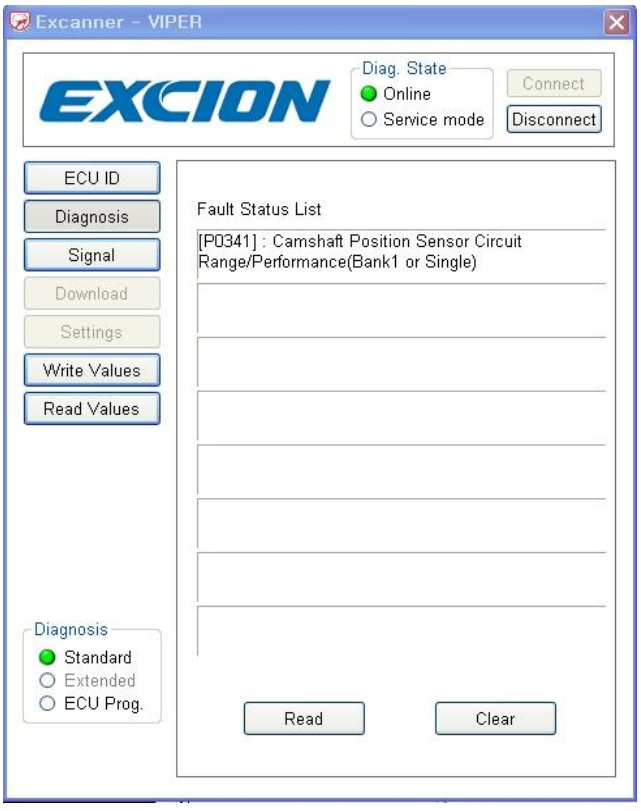
Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Camshaft Position (CMP) Sensor Circuit Bank 1 Sensor A	P0340	Signal check	Abnormal phase edge	-	-	Immediately	Immediately
Camshaft Position (CMP) Sensor Performance Bank 1 Sensor A	P0341	Signal check	Abnormal phase edge(signal pattern is high-high-low-low by tooth problem or noise) > 12 times	-	-	Immediately	Immediately
Camshaft Position (CMP) Sensor Circuit Low Bank 1 Sensor A	P0342	Signal check	Signal low and no phase edge > 12 times	-	-	Immediately	Immediately
Camshaft Position (CMP) Sensor Circuit High Bank 1 Sensor A	P0343	Signal check	Signal high and no phase edge > 12 times	-	-	Immediately	Immediately

Picture30]: SCAN TOOL_P0340_plausibility test phase sensor circuit malfunction

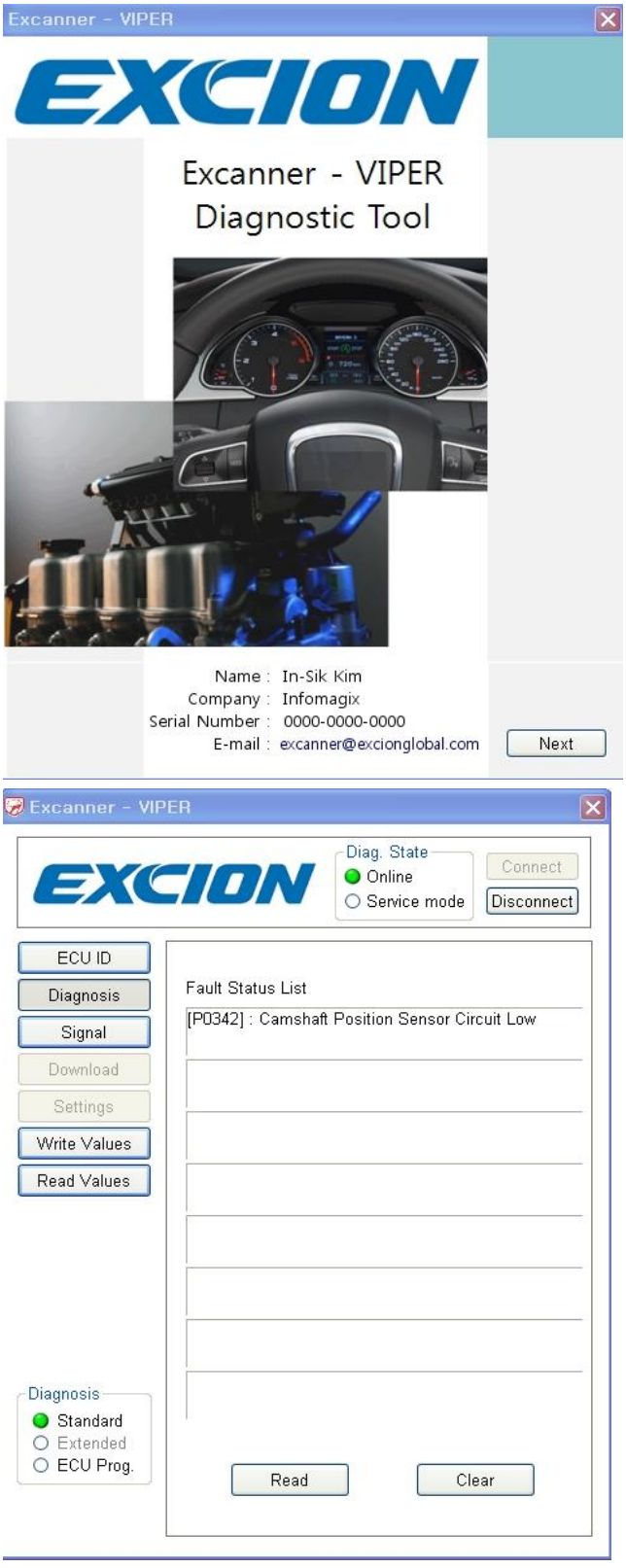


[Picture31]: SCAN TOOL_ plausibility test phase sensor perfomance

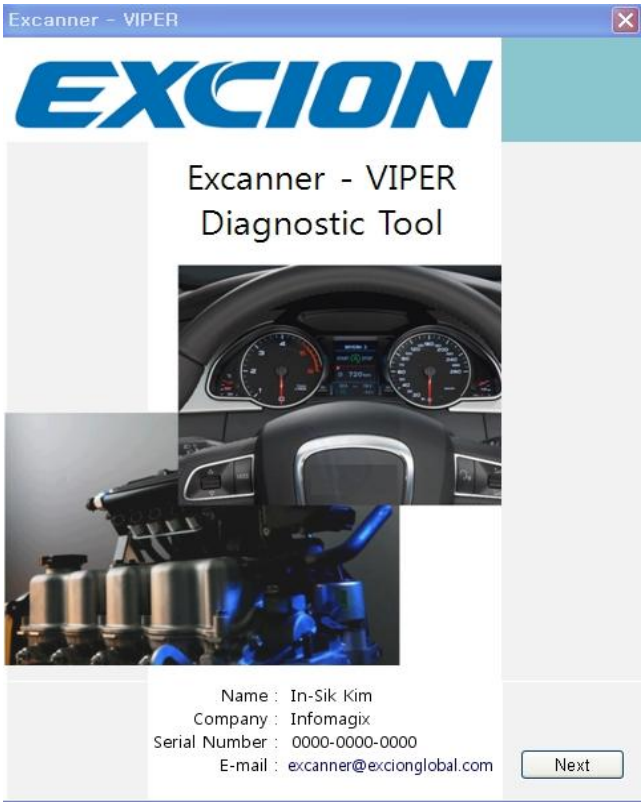




[Picture32]: SCAN TOOL_P0342_Plausibility test phase sensor low



[Picture33]: SCAN TOOL_P0343_Plausibility test phase sensor high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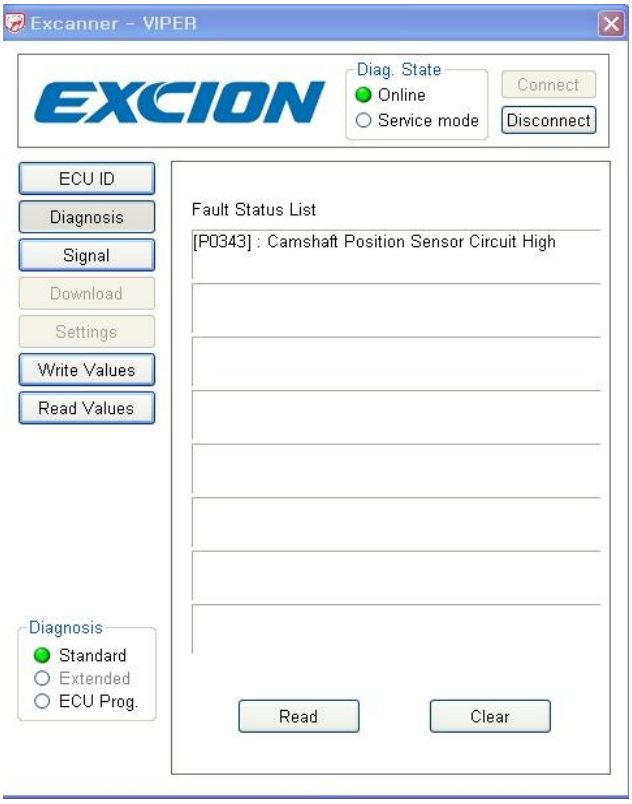
EXCION
Excanner - VIPER
Diagnostic Tool
Name : In-Sik Kim
Company : Infomagix
Serial Number : 0000-0000-0000
E-mail : excanner@excionglobal.com
Next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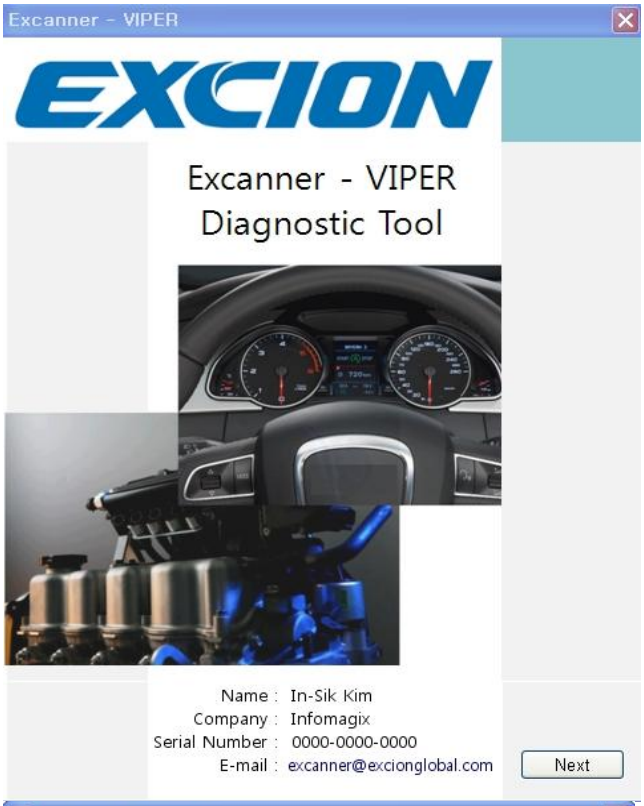
EXCION
Diag. State
Online
Service mode
Connect
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0343] : Camshaft Position Sensor Circuit High
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

2.10 Diagnosis; plausibility test vehicle speed

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Vehicle Speed Sensor Range / Performance	P0501	Minimum vehicle speed detect	Vehicle speed montoring within rpm range	Gear, coolant, rpm threshold	-	Immediately	Immediately

[Picture37]: SCAN TOOL_ Diagnosis; plausibility test vehicle speed performance.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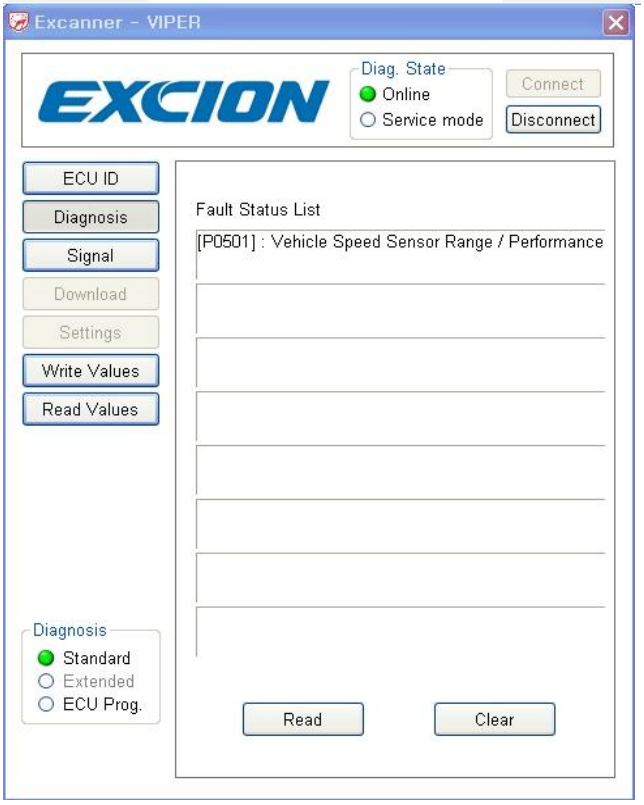
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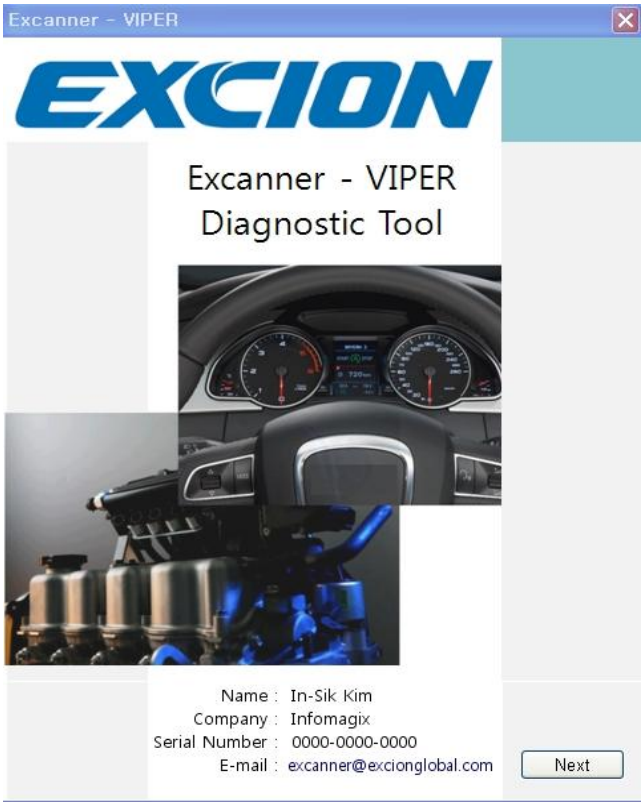
Online
Service mode
Connect
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0501] : Vehicle Speed Sensor Range / Performance
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

2.11 Diagnosis; Input of high / low vehicle speed selection switch

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Vehicle Overspeed Condition	P1297	Vehicle overspeed condition	Vehicle & vehicle speed S/W	-	-	TODDHLSVS	TOD_DHHLSVS

[Picture38]: SCAN TOOL_P0501_Plausibility test vehicle speed perfomance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Company : Infomagix
Serial Number : 0000-0000-0000
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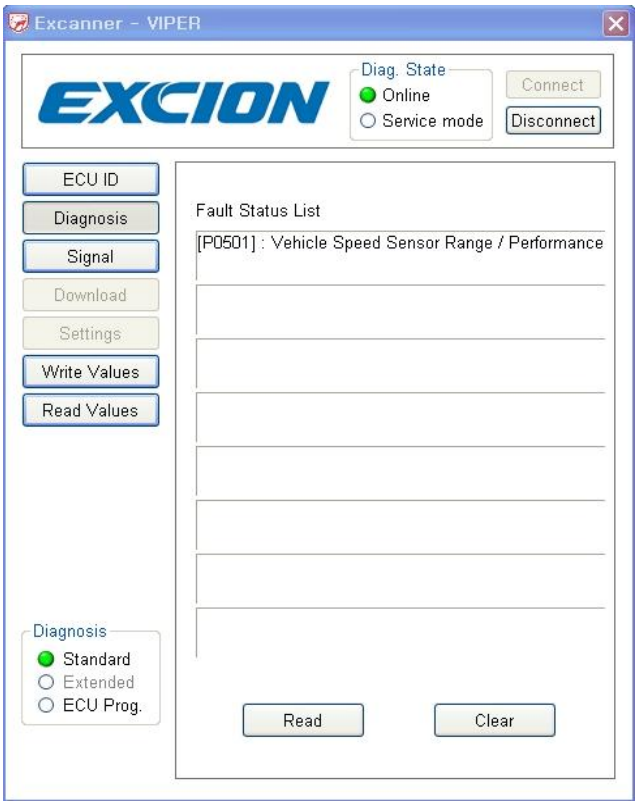
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EXCION
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Online
Service mode
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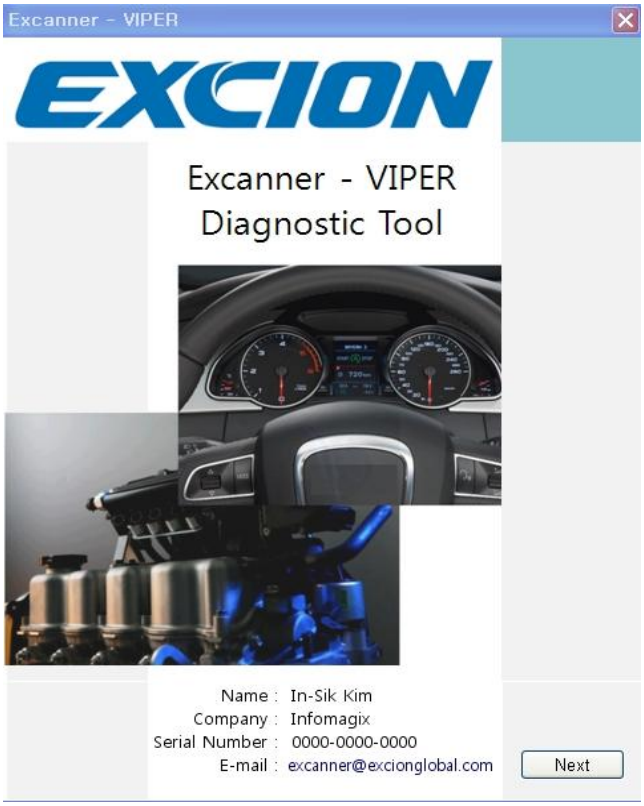
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0501] : Vehicle Speed Sensor Range / Performance
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

2.12 Diagnosis: Input of idle validation switch

Description							
Indicated Parameter	DTC Code	Monitoring strategy description	Primary Malfunction Detection Parameter	Secondary Monitoring Parameter & Condition	Default mode action	Detection Time	Healing Time
Idle switch - Closed Throttle Position Switch	P0510	Idle SW position valid	Idle condition and pedal position	-	-	Immediately	Immediately

[Picture39]: SCAN TOOL_P0510_Input of idle validation switch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Company : Infomagix
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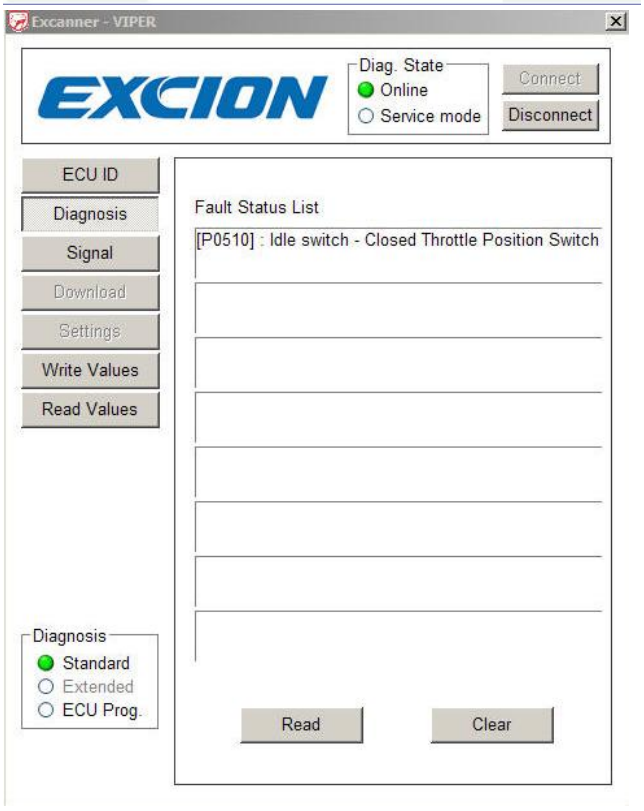
Excanner - VIPER
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Diag. State
Online
Service mode
Connect
Disconnect
ECU ID
Diagnosis
Signal
Download
Settings
Write Values
Read Values
Fault Status List
[P0510] : Idle switch - Closed Throttle Position Switch
Diagnosis
Standard
Extended
ECU Prog.
Read
Clear

FUEL SYSTEM

REPAIR INSTRUCTIONS

PROPANE FUEL SYSTEM PRESSURE RELIEF

⚠ WARNING

The propane fuel system operates at pressure up to 21.5 BAR(312 psi). To minimize the risk of fire and personal injury, relieve the propane fuel system pressure (where applicable) before servicing the propane fuel system components.

To relive propane fuel system pressure :

1. Close the manual shut-off valve (MSV) on the propane fuel tank.
2. Start and run the vehicle until the engine stalls.
3. Turn the ignition switch OFF.

⚠ WARNING

Residual vapor pressure will be present in the fuel system. Ensure the work area is well ventilated before disconnecting any fuel line.

PROPANE FUEL SYSTEM LEAK TEST

⚠ WARNING

Never use an open flame of any type to check for propane fuel system leaks.

Always inspect the propane fuel system for leaks after performing service. Check for leaks at the fittings of the serviced of replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector

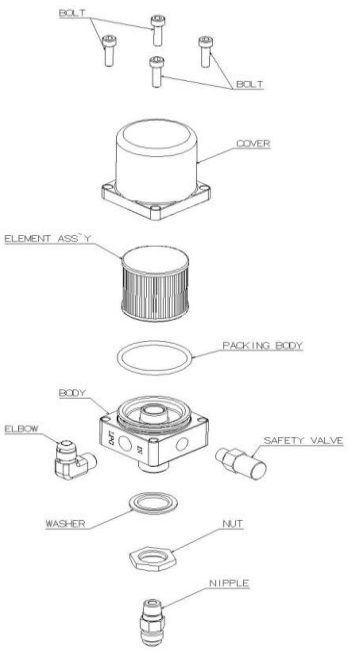

Figure1 BULKHEAD FILTER ASS`Y

PROPANE FUEL FILTER EPLACEMENT (Figure 1)

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slow loosen the fuel inlet hose fitting to relieve any residual fuel pressure.
4. Remove the filter housing retaining bolt and sealing washer discard washer.
5. Remove the filter housing from the bulkhead filter base discard the filter and the sealing ring.
6. Clean and inspect the filter base for any debris.

Installation Procedure

NOTE

Be sure to install new sealing washer and seals Do Not use Teflon tape on the pipe fittings use only a liquid pipe sealant

7. Install the housing seal to the bulkhead base.
8. Install the filter to the bulkhead base.
9. Install the filter housing to the bulkhead base.
10. Install sealing washer and retaining bolt and tighten to specification.
    Tighten
    27 Nm(20 ft lbs)
11. Tighten the fuel inlet hose fitting to specification.
    Tighten
    27 Nm(20 ft lbs)
12. Reconnect the negative battery cable.
13. Open manual shut-off valve
14. Start the vehicle and leak check the propane fuel system at each serviced fitting Refer to Propane Fuel System Leak Test.

LPG VAPORIZER (LV)

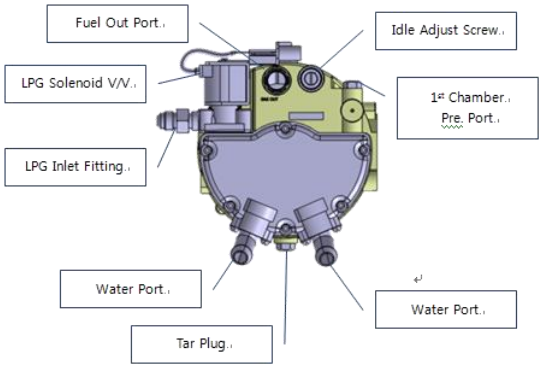

Figure 2 LPG Vaporizer

Removal Procedure

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.

2. Disconnect the negative batter cable.
3. Disconnect the LV electrical connector.
4. Disconnect the LPG fuel inlet line from the LV inlet fitting.
5. Clamp the coolant hoses to the LV or Drain the radiator.
6. Remove the LV. Refer to LPG Vaporizer Replacement.
7. Disconnect the supply and return coolant lines from the LV.

Figure2 LPG VAPORIZER ASS`Y

8. Remove the three(3) LV mounting bolts and retain.
9. Lift LV assembly and remove.
10. Loosen the fuel vapor hose clamp at the LV fuel outlet fitting.
11. Remove the LV.

Installation Procedure

NOTE

Do not use any fuel Teflon tape on fitting. Use a liquid pipe thread sealant when installing fittings.

12. Insert the vapor hose to the fuel outlet fitting and place clamp.
13. Secure the LV to the mounting bracket using the three(3) retaining bolts and tighten to specification.
    Tighten
    14 Nm(10 ft lbs)
14. Install the water inlet line to the fittings and place clamps.
15. Install water outlet line to the fittings and place clamps.
16. Tighten fuel line fitting.
    Tighten
    27 Nm(20 ft lbs)
17. Replace the drained coolant.
18. Install the LV. Tighten the LV finger tight plus 1 to 2 turns and place the LV in the correct position.
19. Install the fuel inlet line.
20. Tighten the fuel line fitting to the LV.
    Tighten
    27 Nm(20 ft lbs)
21. Connect the LV electrical connector.
22. Connect the negative battery cable.
23. Slowly open the tank manual shut off valve.
24. Start the vehicle and leak check the propane fuel system at each serviced fitting.
25. Connect the diagnostic service tool and verify the engine is operating in closed loop and no MIL light is present.

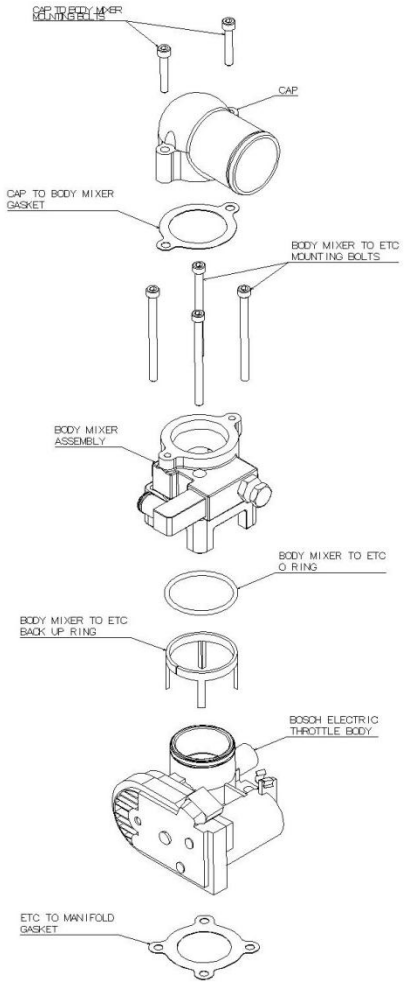

Figure3 LPG MIXER COMPLATE & THROTTLE BODY ASSEMBLY

THROTTLE BODY ASSEMBLY REPLACEMENT
(Figure 3)
Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Disconnect the electronic throttle electrical connector
4. Release mixer fuel inlet hose clamp and remove hose from mixer inlet.
5. Remove the four(4) manifold retaining.
6. Remove the throttle body assembly and retain.
7. Remove gasket, and discard.
8. Remove the throttle body from the body mixer.
9. Remove the o-ring and discard.

Installation Procedure

NOTE

Lightly Lubricate the both the o-rings of the electronic throttle control device to manifold adapter.

Cover Throttle body adapter opening to prevent debris from entering engine until reassembly.

10. Install both the o-ring and back up ring to the throttle body.
11. Insert the throttle body to the body mixer.
12. Install throttle body assembly and gasket to manifold.
13. Secure the assembly with the four(4) retaining bolts.
    Tighten
    12 Nm(106 lb-in)
14. Install fuel supply line to the mixer and reset clamp.
15. Connect the electronic throttle body electrical connection.
16. Connect the air inlet duct.
17. Connect the negative battery cable.
18. Start engine.
19. Start the vehicle and leak check the propane fuel system at each serviced fitting.
20. Connect the diagnostic service tool and verify system is operating closed loop and no MIL light is present.